DESIGN BRANCH

HOUSATONIC RIVER FLOOD CONTROL

NORTHFIELD BROOK DAM & RESERVOIR

NORTHFIELD BROOK

(LOWER NAUGATUCK RIVER, BELOW THOMASTON)

CONNECTICUT

DESIGN MEMORANDUM NO. 1

HYDROLOGY AND HYDRAULICS

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U.S. Army Engineer Division, New England
Corps of Engineers Waltham, Mass.

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NEDGW

31 May 1962

SUBJECT: Northfield Brook Dam and Reservoir - Northfield Brook - Housatonic River Basin, Connecticut - Design Memorandum No. 1 - Hydrology and Hydraulics Analysis

TO: Chief of Engineers
ATTN: ENGCW-E
Department of the Army
Washington, D. C.

There is submitted for review and approval Design Memorandum No. 1 - Hydrology and Hydraulics Analysis for the Northfield Dam and Reservoir - Northfield Brook - Housatonic River Basin, Connecticut, in accordance with EM 1110-2-1150.

FOR THE DIVISION ENGINEER:

John Wm Leslie

1 Incl. (10 cys)
Design Memo No. 1

JOHN WM LESLIE
Chief, Engineering Division

FLOOD CONTROL PROJECT

NORTHFIELD BROOK DAM AND RESERVOIR

NORTHFIELD BROOK

HOUSATONIC RIVER BASIN
CONNECTICUT

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2	Site Geology	12 Apr 1962	8 May 1962
3	General Design		
4	Relocations	30 Apr 1962	
5	Concrete Materials	21 Nov 1961	7 Dec 1961
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NORTHFIELD BROOK DAM AND RESERVOIR

NORTHFIELD BROOK

HOUSATONIC RIVER BASIN

CONNECTICUT

DESIGN MEMORANDUM NO. 1

HYDROLOGY AND HYDRAULIC ANALYSIS

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DESIGN MEMORANDUM NO. 1

A. PURPOSE

1. Purpose. - The purpose of this memorandum is to describe the hydrologic and hydraulic criteria applicable to the design of the Northfield Brook Dam and Reservoir on Northfield Brook in the Naugatuck River watershed, Housatonic River Basin, Connecticut. Part I - Hydrology includes section on climatology, stream flow and spillway and outlet design criteria. Part II - Hydraulic Design includes the analysis and design of hydraulic structures.

PART I - HYDROLOGY

B. BASIN DESCRIPTION

2. Location. - Northfield Brook Dam will be located in the State of Connecticut on Northfield Brook, a tributary of the Naugatuck River, which in turn is a principal tributary of the Housatonic River. The dam site is located about 1.3 miles above the mouth of Northfield Brook in the town of Thomaston. The reservoir at spillway crest will extend about 1.5 miles upstream on Northfield Brook in the towns of Thomaston and Litchfield. The general location of the reservoir site is shown on Plate No. 1-1.

3. Watershed. - The watershed of Northfield Brook above the Northfield Brook damsite is roughly rectangular in shape with a length of about 4.5 miles and a width of about 1.5 miles. The dam will control a drainage area of 5.7 square miles. The elevations at the perimeter of the watershed vary from 480 to 1140 feet with an average of about 850 feet, m.s.l. The stream pattern is basically that of a single stream with short tributaries having steep slopes which produce a condition conducive to rapid runoff during periods of intense rain or snowmelt. From the headwaters to the damsite, Northfield Brook falls approximately 470 feet in about 4 miles. A reservoir map and reservoir profile are shown on Plates Nos. 1-2 and 1-3.

C. CLIMATOLOGY

4. General. - The Naugatuck River Basin has a variable climate characterized by frequent but usually short periods of precipitation. The basin lies in the path of the "prevailing westerlies" and the cyclonic disturbances that cross the country from the west or southwest.

It is also exposed to occasional coastal storms, some of tropical origin, that travel up the Atlantic seaboard. In late summer and autumn months these storms occasionally attain hurricane intensity. The southern portion of the basin, due to its proximity to the Atlantic coast, escapes the severity of cold and depth of snowfall experienced in the higher elevations in the northern part of the watershed.

5. Temperature. - Average monthly temperatures in the Naugatuck River basin vary widely through the year with a mean annual temperature of approximately 47°F., ranging from about 50°F. near the coast to about 44°F. in the headwaters. The minimum temperature recorded in the basin was -25°F; the maximum recorded was 105°F. Freezing temperatures can be expected from the middle of November until the end of March. The mean, maximum and minimum temperatures recorded each month at Norfolk and Waterbury, Connecticut are shown in Table 1 - I below.

TABLE 1-I

MONTHLY TEMPERATURES
(Degrees Fahrenheit)

	Norfolk, Connecticut Elevation 1,380 ft., m.s.l. 15 Years of Record			Waterbury, Connecticut Elevation 340 ft., m.s.l. 69 Years of Record		
Month	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	22.3	62	-22	28.1	73	-19
February	23.6	66	-15	28.3	70	-25
March	29.8	77	-11	37.1	87	0
April	43.7	82	6	48.4	92	11
May	53.9	85	25	59.4	96	26
June	62.7	91	34	68.0	101	33
July	67.8	92	41	72.9	105	41
August	65.8	93	38	70.8	104	35
September	58.4	93	26	64.1	103	25
October	48.6	79	20	53.5	94	17
November	38.0	73	5	42.3	84	2
December	25.4	60	-12	31.1	70	-12
Annual	45.0	93	-22	50.3	105	-25

6. Precipitation. - The mean annual precipitation over the Naugatuck River watershed is approximately 50 inches, uniformly distributed throughout the year. The maximum and minimum annual precipitation at Waterbury for 69 years of record are 66.58 inches in 1901

and 31.21 inches in 1931. The rainfall gage at Waterbury was destroyed in August 1955 and was not replaced until 1957. However, the annual precipitation for 1955 has been estimated at approximately 65 inches. In Norfolk, at the upper limits of the watershed, the total precipitation for 1955 was 74.67 inches with 23.67 and 17.49 inches observed during August and October, respectively. Table 1-II summarizes the precipitation records at Norfolk and Waterbury.

TABLE 1-II

MONTHLY PRECIPITATION RECORD
(In Inches)

	Norfolk, Connecticut Elevation 1,380 ft., m.s.l. 15 Years of Record			Waterbury, Connecticut Elevation 340 ft., m.s.l. 69 Years of Record		
Month	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	4.25	8.32	0.93	3.84	10.06	0.84
February	3.75	5.90	1.11	3.53	10.00	0.43
March	5.00	10.37	1.82	4.07	9.46	0.17
April	4.75	7.19	2.48	3.72	11.51	0.66
May	3.98	6.26	1.70	3.90	8.08	0.13
June	3.97	6.83	1.11	3.57	11.25	0.54
July	4.01	6.86	1.67	4.39	18.10	1.36
August	5.02	23.67	0.65	4.26	9.48*	0.90
September	4.39	9.25	0.92	3.72	12.90	0.90
October	4.44	17.49	1.73	3.49	8.83*	0.20
November	5.14	10.03	1.27	3.83	8.74	0.78
December	5.00	9.56	1.20	3.88	9.82	0.82
Annual	53.7	74.67	39.44	46.20	66.58	31.21

* Probably exceeded in 1955

7. Snow. - The annual snowfall over the Naugatuck River watershed varies from about 35 inches near the coast to over 80 inches in the headwater region. Monthly and annual average snowfall for 40 years at Norfolk are tabulated in Table 1-III.

TABLE 1-III

MEAN MONTHLY SNOWFALL AT NORFOLK, CONNECTICUT

Elevation 1,380 ft., m.s.l.
(Average Depth in Inches)

Month	Snowfall	Month	Snowfall
January	19.1	July	0
February	20.7	August	0
March	18.4	September	0
April	6.6	October	0.4
May	0.3	November	6.3
June	0	December	12.4
		Annual	84.2

Snow cover reaches a maximum depth in late March with the water content in early spring often four to six inches.

8. Storms. - The rapidly moving cyclonic storms or "lows" that travel over or near the Naugatuck River basin from the west or southwest produce frequent periods of unsettled, but not extremely weather. The region is also exposed to occasional coastal storms, some of tropical origin, that travel up the Atlantic coast and move inland over New England. The hurricanes of September 1938 and August 1955 were of this type. The precipitation which accompanied the latter storm averaged more than 13 inches in the upper Naugatuck River watershed and ten inches in the lower basin, falling on ground already saturated by more than seven inches of rain during hurricane "Connie" the previous week. The location of centers of this and other outstanding storms of record in the northeastern United States are shown on Plate No. 1-4 together with their depth-area characteristics.

D. RUNOFF

9. Discharge Records. - Two recording U. S. Geological Survey gaging stations with substantial periods of record were located in the Upper Naugatuck River basin as indicated on Plate No. 1-1. These were located on Leadmine Brook near Thomaston (D.A. = 24.0 sq. mi.) and on the Naugatuck River near Thomaston (D.A. = 71.9 sq. mi.). The discharge hydrographs for the period of record (1930-1959) for the gaging station on Leadmine Brook are shown on Plates No. 1-5 and 1-6. Conditions at this location are believed to approximate those along Northfield Brook with appropriate correction for difference in drainage areas.

In September 1959, the construction of Thomaston Dam made it necessary to move the station on Leadmine Brook upstream (D.A. = 18.9 sq. mi.). The gaging station on the Naugatuck River near Thomaston was moved downstream below the dam (D. A. = 100 sq. mi.) for the same reason. The new locations of the gaging stations are also shown on Plate No. 1-1.

10. Stream Flow Data. - The annual runoff for the 28 years of record through September 1959 for the Leadmine Brook gage near Thomaston varied from 13.71 inches to 41.41 inches with a mean of 27.15 inches. Table 1-IV is a summary of the maximum, minimum and mean monthly runoff in inches for the period of record at the gaging station on Leadmine Brook near Thomaston.

TABLE 1-IV
MONTHLY RUNOFF
(In Inches)

October 1931 - September 1959

Leadmine Brook near Thomaston, Connecticut
(D.A. = 24.0 sq. mi.)

Month	Mean	Maximum	Minimum
January	2.72	6.05	0.51
February	2.27	5.55	0.48
March	5.02	11.24	2.18
April	4.41	10.60	1.94
May	2.65	5.72	1.03
June	1.38	3.90	0.19
July	0.83	5.28	0.04
August	0.87	10.18	0.03
September	0.90	5.26	0.03
October	1.26	11.76	0.06
November	2.19	7.39	0.12
December	2.46	4.51	0.50
Annual	27.15	41.41	13.71

E. HISTORY OF FLOODS

11. General. - Outstanding floods on the Naugatuck River may result from early spring storms combined with melting snow, such as the flood of March 1936 or from summer and fall storms such as the record flood of August 1955. In addition, local thunderstorms can cause serious flash floods in the smaller streams.

12. Floods of Record. - Since 1900, there have been many floods with major ones occurring in November 1927, March 1936, September 1938, New Year's 1949, and August and October 1955. The storm of August 1955, by far the greatest flood of record on the Naugatuck River, was caused by heavy rainfall on ground already saturated by rainfall from hurricane "Connie" occurring during the previous week. Table 1-V is a summary of the major peak discharges at the two gaging stations on Leadmine Brook and on the Naugatuck River near Thomaston.

TABLE 1-V

MAJOR FLOODS - NAUGATUCK RIVER BASIN

	Leadmine Brook near Thomaston	Naugatuck River near Thomaston
Drainage Area (sq. mi.)	24.0	71.9
Flood	Peak Discharge (c.f.s.)	Peak Discharge (c.f.s.)
November 1927	5,000 (est.)	10,000 (est.)
March 1936	2,680	6,590
September 1938	3,050	9,970
December 1948	5,150	10,200
August 1955	10,400	41,600
October 1955	3,100	8,800

13. It has been estimated that the peak discharge experienced on Northfield Brook at the damsite in August 1955 was about 3,200 c.f.s. This was based on drainage-area relationships with other small tributaries in the Naugatuck River basin, with allowances made for the rainfall distribution. The following table (1-VI) indicates how the estimated peak compares with data published by the U. S. Geological Survey in Water Supply Paper 1420, "Floods of August-October 1955, New England to North Carolina."

TABLE 1-VI

FLOOD OF AUGUST 1955 ON
TRIBUTARIES OF THE NAUGATUCK RIVER

Stream	Drainage Area (Sq. Mi.)	Peak Discharge cfs	Peak Discharge csm
Leadmine Brook	24.0	10,400	433
*Northfield Brook	5.7	3,170	555
Branch Brook	21.0	10,300	490
Hancock Brook	12.9	4,870	378
Steel Brook	12.9	5,890	455
Mad River	18.0	2,070	115
Hop Brook	16.5	2,650	160

*Estimated

F. RESERVOIR CAPACITY

14. General. - Northfield Brook Reservoir will be used primarily for flood control purposes. To mitigate fish and wildlife losses occurring from project construction and operation, a small pool will be maintained at approximately elevation 500 ft., m.s.l. Pertinent data on the Northfield Brook Reservoir are tabulated in Table 1-VII and the area-capacity curves are shown on Plate No. 1-7.

TABLE 1-VII

PERTINENT DATA - NORTHFIELD BROOK RESERVOIR

	Elevation Ft., m.s.l.	Water Area (Acres)	Capacity Acre-Feet	Capacity Inches
River Bed at Site	462	0	0	0
Permanent Pool Storage	500	8	82	0.3
Flood Control Storage (net)			2350	7.7
Spillway Crest	576	67	2432	8.00

15. Flood Control Storage. - Prior to 1955 it was considered that there should be sufficient storage capacity in a flood control reservoir to hold six inches of runoff from the watershed upstream of the project. Following the major floods of 1955, a reappraisal was made of storage requirements in flood control reservoirs in New England. In general, the volume of runoff experienced in the 1955 floods has demonstrated

that it is desirable to provide at least 8 inches whenever feasible. On this basis, the Northfield Brook project was recommended for authorization as an 8-inch flood control reservoir. Prior to final authorization, the storage was modified to provide for a small permanent pool to mitigate fish and wildlife losses.

16. With the completion of the Thomaston Dam and control of the Upper Naugatuck River, the source of future flooding in the lower Naugatuck River basin will be the many small steep tributaries with rapid runoff characteristics. Any reduction and desynchronization of the contributions from these tributaries will effectively reduce flood peaks on the lower Naugatuck River. The 7.7 inches of flood control storage in the Northfield Brook Reservoir was tested on the August 1955 flood and the standard project flood and was found to be adequate (Plates Nos. 1-10 and 1-11).

G. UNIT HYDROGRAPH ANALYSIS

17. General. - Stream flow records are available from 1931 through 1959 for the gaging station on Leadmine Brook (D.A. = 24.0 sq. mi.). Precipitation records are available for 15 years at Norfolk and 69 years at Waterbury.

18. Unit Hydrograph. - The runoff characteristics of Leadmine Brook are considered to be typical of tributaries of the Naugatuck River. Therefore, in an analysis similar to that used for Hall Meadow Brook Dam (Design Memo No. 1, May 1960), the flood hydrograph for August 1955 on Leadmine Brook was used to derive two-hour hydrographs for all the authorized flood control dams on tributaries of the Naugatuck River. These unit hydrographs, shown on Plate No. 1-8, were derived from drainage area relationships with adjustments for the times of concentration. The adopted two-hour unit hydrograph for the Northfield Brook Reservoir has a peak of 810 c.f.s. and a lag time of 2 hours.

H. SPILLWAY DESIGN FLOOD

19. General. - The spillway design flood represents the most severe conditions of runoff that would result from the probable maximum precipitation falling on ground saturated from previous rains. Concurrently it is assumed that the reservoir initially is filled to spillway crest as a result of previous storms. Discharge through the conduit is relatively small, hence was neglected during routing computations to determine the spillway design discharge.

20. <u>Probable Maximum Precipitation</u>. - Values of rainfall for the spillway design flood were obtained from Hydrometeorological Report No. 33, Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian, dated April 1956, as prepared by the Hydrometeorological Section of the U. S. Weather Bureau.

21. Due to the proximity of the damage zone at Thomaston, it was considered that the design of the spillway should provide a high degree of protection from overtopping. However, the possibility of a storm producing probably maximum precipitation orienting itself over the configuration of the small watershed seemed rather remote. Thus, the adopted storm for the derivation of the spillway design flood for the Northfield Brook Reservoir was selected as 100 percent of the all season average probable maximum precipitation for 50 sq. miles. This is consistent with the precipitation values used for the Hall Meadow and Mad River Reservoirs presently under construction. The average 50 square mile precipitation values vary from 83 to 93 percent of the rainfall values obtained by concentrating the probable maximum storm directly over the drainage areas of the authorized smaller reservoirs in the Naugatuck River Basin. From figures 1 and 2, Hydrometeorological Report No. 33, the probable maximum precipitation for Northfield Brook Reservoir was determined as follows:

Duration in Hours	Per Cent of Index Rainfall*	Precipitation (Inches)
6	92	19.2
12	106	22.2
24	116	24.4

*Per cent to be applied to 200 square miles - 24 hour probable maximum precipitation of 21.0 inches.

22. The distribution of the precipitation in 2-hour periods and the determination of the rainfall excess is shown in Table 1-VIII. It was assumed that the rainfall intensity was uniform during the maximum six-hour period. Losses from infiltration, surface detention and transpiration were assumed at a rate of 0.05 inch per hour, which is consistent with minimum losses determined in previous studies for the New England area.

TABLE NO. 1 - VIII

PROBABLE MAXIMUM PRECIPITATION

Time (Hours)	Maximum Precipitation (Inches)	Losses (Inches)	Rainfall Excess (Inches)	Rainfall Pattern (Inches)
0	-	-	-	-
2	6.4	0.1	6.3	0.1
4	6.4	0.1	6.3	0.2
6	6.4	0.1	6.3	0.4
8	1.1	0.1	1.0	0.8
10	1.0	0.1	0.9	1.0
12	0.9	0.1	0.8	6.3
14	0.6	0.1	0.5	6.3
16	0.5	0.1	0.4	6.3
18	0.4	0.1	0.3	0.9
20	0.3	0.1	0.2	0.5
22	0.2	0.1	0.1	0.3
24	0.2	0.1	0.1	0.1
Total	24.4	1.2	23.2	23.2

23. Spillway Design Flood Inflow. - The spillway design flood inflow to Northfield Brook Reservoir was derived by applying the rainfall excess of Table 1-VIII to the adopted unit hydrograph. The resulting hydrograph has a peak of 9,000 c.f.s. and is shown on Plate No. 1-9.

24. Spillway Design Flood Outflow. - Assuming the reservoir initially full to spillway crest from previous floods and disregarding flow through the outlet, the design flood was routed through reservoir storage using the capacity curve (Plate No. 1-7) and the spillway rating curve (Plate No. 1-15). The resulting maximum spillway discharge was 8800 c.f.s. with a maximum water surface elevation of 586.1 ft., m.s.l., equivalent to 10.1 feet of surcharge. Plate No. 1-9 is a summary of the spillway design flood analysis for Northfield Brook Dam.

25. Spillway Design Flood with Snowmelt. - Although no snowmelt was used in the spillway design flood, consideration was given to a flood which would include runoff snowmelt. A study of hydrometeorological and hydrologic reports showed that a maximum precipitation for spring storms combined with snowmelt could produce a greater volume of runoff than a summer storm. However, the greater rainfall amounts and higher intensities of a summer storm would produce a higher flood peak,

which would be a more serious criterion for a spillway design flood. Furthermore, should a spring-type flood be developed for analysis, it is logical to assume that if heavy snow cover were on the ground there would have been no antecedent runoff, and the reservoir would be empty at the start of the spillway design flood. This assumption would further decrease the severity of the flood in respect to design requirements.

I. TOP OF DAM ELEVATION

26. Freeboard. - Freeboard refers to the difference in elevation between the maximum water surface and the top of the non-overflow sections of the earth embankments constituting the dams and dikes. A determination of wave height, runup and wind setup followed the procedure outlined in a memorandum concerning "Conference on Determination of Freeboard Requirements for the McGee Bend Dam, Angelina River, Texas", dated 1 August 1956. Winds producing maximum waves and setup on the slope of Northfield Brook Dam would have to be from a northwest direction due to the orientation and shape of the reservoir. Information on maximum wind velocity and direction at Hartford, Connecticut for 42 years of record is shown in Table 1-IX.

TABLE 1-IX

MAXIMUM WINDS AT HARTFORD, CONNECTICUT
Elevation 169 ft., m.s.l.
42 Years of Record

Fastest Mile (m.p.h.)	Direction	Date
70	East	November 1950
62	North	September 1944
57	South	October 1920
57	Southeast	March 1952
56	Northeast	August 1954
54	Northwest	December 1951

27. Although it is highly improbable that winds of hurricane velocity would occur at the time of maximum surcharge during a spillway design flood, winds of 80 miles per hour over water were selected for computation of wave height and set-up for Northfield Brook Reservoir. The significant wave height for the maximum effective fetch of .29 miles is 2.0 feet. A relative run-up ratio of 1.0 was used since the embankments will be riprapped at a slope equal to 1:3. Wind set-up is negligible because of the fetch restriction and depth of water. The minimum standard of five feet of freeboard for an earth embankment was adopted for design.

28. Selected Elevation, Top of Dam. - The top elevation of the Northfield Brook Dam was determined by the following data:

Elevation, Crest of Spillway, m.s.l.	576.0
Maximum Spillway Surcharge (in feet)	10.1
Minimum Freeboard (in feet)	5.0
Total	591.1
Adopted Elevation for Top of Dam	591.0

J. RESERVOIR OUTLET CAPACITY

29. General. - The outlet for the Northfield Brook Dam will consist of a single circular conduit, controlled by a sluice gate locked in a partially open position. The capacity of the outlet must be adequate (a) to pass the normal flow of the stream and the safe channel capacity without imposing restrictions on the rights of riparian owners below the dam and without using more than a minor portion of the storage capacity of the reservoir; (b) to reduce flood flows so that the uncontrolled discharge will not seriously affect river stages in downstream damage centers; (c) to permit evacuation of the reservoir within a reasonable time after a flood; and (d) to pass a flood of reasonable size during construction without requiring cofferdams of excessive height.

30. It was found that for the required length of 564 feet an ungated circular conduit with a diameter of 30 inches would meet the above criteria. As inspection and maintenance of a 30 inch conduit of this length would be quite difficult, a 36 inch diameter was considered to be a practical minimum size. As indicated in the following paragraphs, a 36 inch circular conduit, with discharge controlled at the entrance by a 3 foot x 3 foot sluice gate locked in a predetermined position with a 1.1 foot opening, was found to meet the desired discharge criteria and was adopted. The gate will be left wide open during construction of the dam to obtain maximum diversion capacity. After completion of the dam the gate will be opened wide only for inspection and maintenance of the conduit.

31. Ungated vs. Gated Outlet. - For purposes of flood control operation, the proposed conduit with the gate locked in a predetermined position is considered comparable to an ungated and unattended detention structure. The additional cost of a gate tower and access bridge to permit gate regulation at all ranges of pool elevation was considered to be unwarranted. Northfield Brook will be one of four reservoirs to be located on tributaries downstream of the completed Thomaston Dam. As discussed in paragraph 15, the source of future flooding in the

lower Naugatuck River will be from the many small steep tributaries with rapid runoff characteristics located downstream of Thomaston Dam. Any reduction and desynchronization of the contributions from these tributaries will effectively reduce flood peaks on the main river. For these reasons, Northfield Brook Dam and Hancock Brook Dam (D.A = 12.0 sq.mi.) will have fixed outlets of predetermined capacity. The Black Rock Dam (D.A = 20.8 sq.mi.) on Branch Brook and the Hop Brook Dam (D.A = 16.0 sq.mi.) will be gated to permit some flexibility in the regulation of the flows from the larger drainage areas.

32. In a recurrence of the record flood of August 1955, the contributions from the Northfield and Hancock reservoirs at the time of the modified peak discharge at Waterbury (23,500 cfs) and Ansonia (54,000 cfs) will be about 400 cfs. This is considered to be negligible in the contribution to damages that may be experienced.

33. Outlet Discharge During Floods. - Since the Northfield Brook Reservoir will operate as an automatic detention basin, its effectiveness at the major damage center of Thomaston, Connecticut and the required time of emptying are directly related to the size of the outlet. With the proposed 36 inch diameter conduit and the partially open sluice gate, the downstream channel capacity of 160 cfs will not be exceeded until the pool approaches the spillway crest. In addition to the advantage of inspection and maintenance, the proposed design permits adjustment in the outlet capacity. If operational experience indicates that a change in discharge capacity is desirable, the gate opening will be changed and the gate relocked in place. The time required to drain the pool from spillway crest will be about 10 days, but it will be possible to have six inches of storage available in 7 days. Table 1-X shows a comparison of outlet capacities of small reservoirs recently designed for the Naugatuck River basin and vicinity.

TABLE 1 - X

OUTLET CAPACITIES - SMALL RESERVOIRS

Reservoir	Drainage Area Sq.Miles	Storage Gross (Inches)	Outlet Discharge at Spillway Crest C.F.S.	C.S.M.
Hall Meadow Brook	17.2	9.4	455	26
Mad River	18.2	10.0	435	24
East Branch	9.3	8.9	235	25
Hancock Brook	12.0	6.3	375	31
Northfield Brook	5.7	8.0	160	28

34. <u>Stream Diversion During Construction.</u> - The construction schedule requires the construction of a temporary cofferdam to divert the stream through the outlet in order to construct the foundation of the dam in the dry. The Northfield Brook construction flood was based on a drainage area relationship with the construction flood used in the design of Hall Meadow Dam. The peak inflow of a 10 year flood to Northfield Brook Reservoir was determined to be 1800 cfs. with a volume of 4 inches. With both the weir gate and the conduit gate fully open, the maximum pool would be about elevation 543 and the maximum outflow about 205 cfs. In lieu of a temporary cofferdam it is planned to construct the total embankment to a minimum elevation of 550 feet during the first construction season.

K. RESERVOIR REGULATION

35. <u>General.</u> - As discussed in paragraphs 29 through 33, Northfield Brook Reservoir will act as an automatic detention basin, and in conjunction with other reservoirs in the Naugatuck River Basin will desynchronize the peak flows of Northfield Brook from those of the uncontrolled tributaries.

36. The adopted reservoir outlet size of 3 feet and the partially open gate setting was tested on the flood of record (August 1955) and the standard project flood. The effectiveness of the reservoir on these two floods is shown on Plates No. 1-10 and 1-11. In the routing of the August 1955 flood, it was assumed that at the beginning of the runoff from hurricane "Diane", the reservoir had not been completely emptied of the runoff from Hurricane "Connie".

37. <u>Regulation Records.</u> - In accordance with EM-1110-2-3600, Reservoir Regulation, a pool stage recorder will be installed at the Northfield Brook Dam. In the absence of a gate tower with a float well, a bubble gage similar to the type developed by the U. S. Geological Survey will be installed. With a conduit rating curve, this would provide a record of outflows from the dam. It is anticipated that the computed rating curve for the conduit will be checked by field stream measurement. A record of the pool stages will also permit determination of reservoir inflow.

38. <u>Radio Gage.</u> - Releases from the Thomaston Flood Control Dam must be coordinated with the outflow from Northfield Brook to provide the maximum protection for the town of Thomaston, city of Waterbury and other downstream communities. Since the dam will be unattended, consideration is being given to a transmitter (that will be "on call" or automatic" to provide the necessary data to the operator at Thomaston Dam.

Due to the exposure to "hurricanestorms" that could disrupt telephone and power service, a battery-operated radio transmitter is considered to be the most reliable. Plans are being considered to provide a radio hydroclimatic network in the Naugatuck River valley that will include the Northfield Brook reservoir gage.

39. Frequency of Filling. - Plate No. 1-12 is a curve denoting the estimated frquency of filling the proposed Northfield Brook Reservoir. It was developed from an analysis of stream flow records and the regulation of existing flood control reservoirs. Flood experience on ungated structures in New England is very limited. Therefore, the frequency curve was first developed from experienced data assuming the reservoir gated and then modified on the basis of testing the floods of record, and allowing for the possibility of two moderate floods within a one week period or less. This curve is considered a reasonable guide for real estate acquisition.

PART II

HYDRAULIC DESIGN

L. SPILLWAY

40. General. - The natural topography at the damsite and the favorable location of rock in the left abutment led to the selection of a chute spillway. The spillway structure will consist of a low ogee weir with a vertical upstream face and a discharge channel excavated in rock. The general plan and profile of the spillway are shown on Plates Nos. 1-13 and 1-14.

41. Length of Crest and Maximum Surcharge. - Assuming various lengths of spillway from 50 to 100 feet, the spillway design flood was routed through the surcharge storage with the reservoir full to determine the effect on surcharge head and corresponding elevation for the top of the dam. A spillway length of 72 feet was adopted. The reservoir pool for the selected length was elevation 586.1 feet, m.s.l., with a corresponding discharge of 8800 c.f.s. Routing the spillway design flood thru the reservoir with only 6 inches of storage at the beginning of the flood resulted in no appreciable decrease in surcharge height or spillway discharge.

42. Approach Channel. - The approach channel to the spillway will be at elevation 571 providing an approach depth of 5 feet below the spillway crest. This will create a channel of

about 150 feet in length with the bottom sloped away from the weir for drainage. The average velocity in the approach channel during the spillway design flood will be about 9 feet per second. Computations indicated that the head loss in the approach channel was about .2 foot.

43. Crest Shape. - The shape of the weir was determined from procedures prescribed for a low ogee crest in EM-Hydraulic Design-Spillways, Part CXVI, Chap. 3 and is shown on Plate No. 1-16. The shape was based on a design head of 10 feet which includes a velocity head of 1.15 feet. With a vertical upstream face, the required compound curve has radii of 4.86 and 2.09 feet. The equation of the coordinates of the downstream section is $Y = .0729X^{1.8295}$. To facilitate the construction of the weir, a tangent with a slope of 0.60 was used to separate the parabolic curve from the bucket curvature which has a radius of 10 feet. The toe of the weir is set at elevation 572, one foot above the proposed channel grade to avoid the possibility of the uneven rock excavation interfering with the flow. Coordinates of the "upper nappe" were determined from Bulletin No. 3, Boulder Canyon Report.

44. Discharge Coefficients. - The determination of the spillway discharge coefficients for various heads up to maximum surcharge was based on the following considerations: (a) design head; (b) depth of approach channel; (c) effect of vertical upstream face; (d) effect of submergence and apron interference. Plates 6 and 10 in EM - Spillways were used in the derivation of these coefficients. A summary of the computed discharge coefficients is shown on Plate No. 1-15.

45. Discharge Rating Curve. - A weir rating curve was developed considering both static and velocity heads at a location about 25 feet upstream of the weir. Plate No. 1-15 is a plot of the spillway rating curve as related to the elevation in the pool which combines the weir rating curve and the head losses in the approach channel.

M. SPILLWAY CHUTE

46. General. - The plan and profile of the adopted spillway chute is shown on Plates Nos. 1-13 and 1-14. It is the result of a number of trials involving variations of toe elevation, bottom slope, angle of convergence and width of channel downstream of the contraction. The hydraulic analyses were based on the maximum spillway discharge of 8800 cfs, starting with the energy gradient at the toe of the weir and computing a dropdown curve for the determination of water survace profiles and average velocities.

47. Selected Chute. - The selected grade and depth of chute more than satisfies the minimum hydraulic and freeboard requirements since it was decided to use this location as a source of rock for the embankment. The chute converges from 69.5 feet at the toe of the weir (station 3+12.) to a minimum width of 40 feet at station 5+47. At station 5+40 the bottom slope along the base line of the chute changes from about 22 per cent to 7.5 per cent. At station 7+00 the slope increases to 24 per cent which is maintained to station 8+80. A slope of 1 per cent is then continued to the existing river channel. The design discharge will be confined in rock until about station 10+50. Beyond this station, any overflow from the channel will not endanger the embankment of the dam. The computed average velocities in the chute under design discharge conditions will vary from 24 to 47 feet per second.

N. OUTLET

48. Conduit. - As discussed in paragraphs 29 through 33, a 3 foot circular conduit, controlled at the entrance by a 3 foot x 3 foot sluice gate set in position with an opening of 1.1 feet, was adopted. The conduit from entrance to exit (including transition) will have a length of 564 feet. The entrance invert elevation will be 476.0 to satisfy existing rock conditions, and the portal invert elevation will be 474.0, m.s.l.

49. Control Weir. - The trapezoidal intake channel will have a bottom width of 10 feet and elevation 480 feet, m.s.l. A concrete structure at the entrance to the conduit (Plates Nos. 1-17 and 1-18) will maintain a permanent pool. This pool will have an area of about 8 acres at a tentative elevation 500 ft., m.s.l. To permit flexibility in the final adopted pool elevation, the weir will include 2 stop-log sections, each 5 feet in length with sills at elevation 498.0. Drawdown of the pool behind the weir will be accomplished with a hand operated sluice gate, 2 ft. x 3 ft., located in the upstream face of the weir with a gate invert at 480.5 ft., m.s.l. A metal trash rack with eight (8) inch spacings will span the weir portion of the intake. The average velocities through the unobstructed opening with the pool at spillway crest will be less than one (1) foot per second.

50. Conduit Entrance. - Since the maximum velocity of nearly 50 feet per second through the gated opening would cause negative pressures, the entrance to the 36 inch square opening was designed in accordance with criteria for rectangular conduit entrances. The vertical curve at the intake was determined from the following formula: $\frac{X^2}{D^2} + \frac{Y^2}{\left(\frac{2D}{3}\right)^2} = 1,$

where D = 3 feet. This would also provide for the maximum hydraulic efficiency in the conduit during construction when the gate would be fully open. The need for the elliptical shape in the horizontal direction will not be critical since the flow will be suppressed by the side walls. Therefore, the horizontal entrance to the conduit is designed as a circular curve with a radius of 10 feet. A transition section of 8 feet in length will provide fillets from the 3-foot square entrance to the 3-foot diameter circular section of the conduit.

51. Air Vent. - As the gate will be only partially open, an air vent will be provided to prevent negative pressures. Assuming the water surface at the maximum surcharge elevation of 586.1 ft., m.s.l., and a maximum air velocity of 150 feet per second, an air vent size was computed for the gate opening of 1.1 feet. This resulted in an air demand of 88 c.f.s. and a vent area of 0.59 square feet (10.4" diam. pipe). It is improbable that the dam would ever be operated with an 80 per cent gate opening (condition of maximum air demand) but if such was the case, the air demand would be 135 c.f.s. and the required vent area would be .90 square feet (12.8" diameter pipe). It was decided that a 12" diameter pipe would be satisfactory and was adopted (Plate No. 1-17). A transition to a vent 3'-0" by 6" will be provided to enter the gate passage immediately downstream from the gate and will be shaped to prevent cavitation tendencies.

52. Outlet Rating Curve. - Rating curves for the conduit and intake works, including the weir and conduit gates, are shown on Plate No. 1-19. The two conditions indicated are (1) during construction, both gates fully open and (2) after completion, the weir gate closed and the conduit gate set at an opening of 1.1 feet. The required gate opening of 1.1 feet was established on the basis of an available head of 67 feet and a coefficient of discharge C = 0.74. The head loss due to friction in the 36" conduit will be about 33 feet (assuming the conduit flowing full, n = .013).

53. An analysis of the curves indicates that upon completion of the project and gates set in condition (2), the weir will be the control until the discharge exceeds about 80 c.f.s. At that time, the weir will become submerged and the gated conduit will be the control. During construction, with both gates open, the weir will never be the control. Under this condition the control will shift from the weir gate opening to the ungated conduit when the flows exceed about 110 c.f.s. Pressure and energy gradient profiles for the two conditions of gate openings with the pool at spillway crest are shown on Plate No. 1-17.

54. <u>Outlet Stilling Basin.</u> - From preliminary geologic investigations, it is considered that the bedrock in which the outlet channel is located is capable of withstanding the average exit velocity of about 23 feet per second which would occur with the pool at spillway crest. Since a stilling basin is not considered necessary, the transition from the portal end of the circular conduit to the 14 ft. trapezoidal discharge channel will be a 25 foot reinforced concrete apron to support and spread the discharge.

CORPS OF ENGINEERS U.S. ARMY

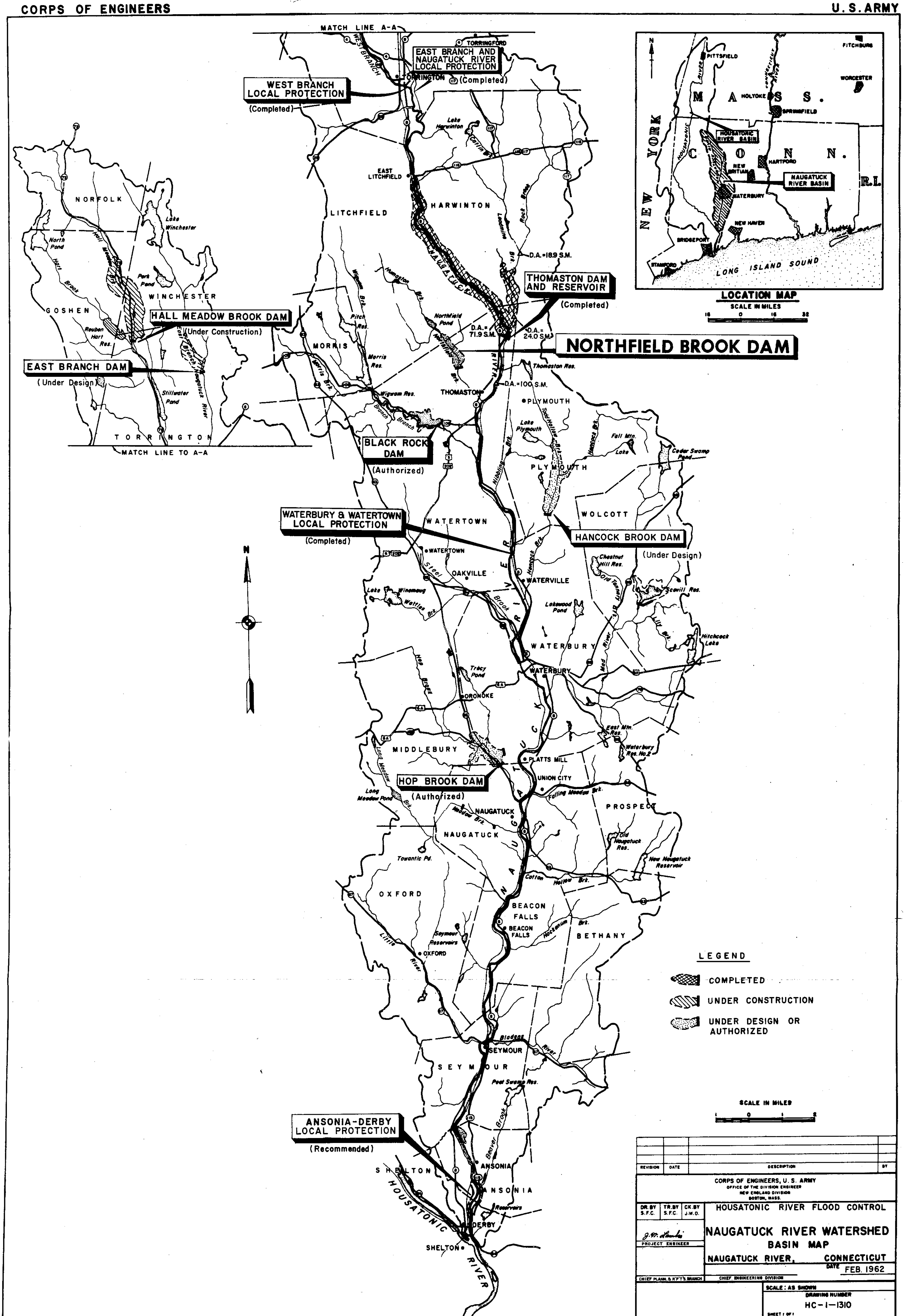


PLATE NO. I-I

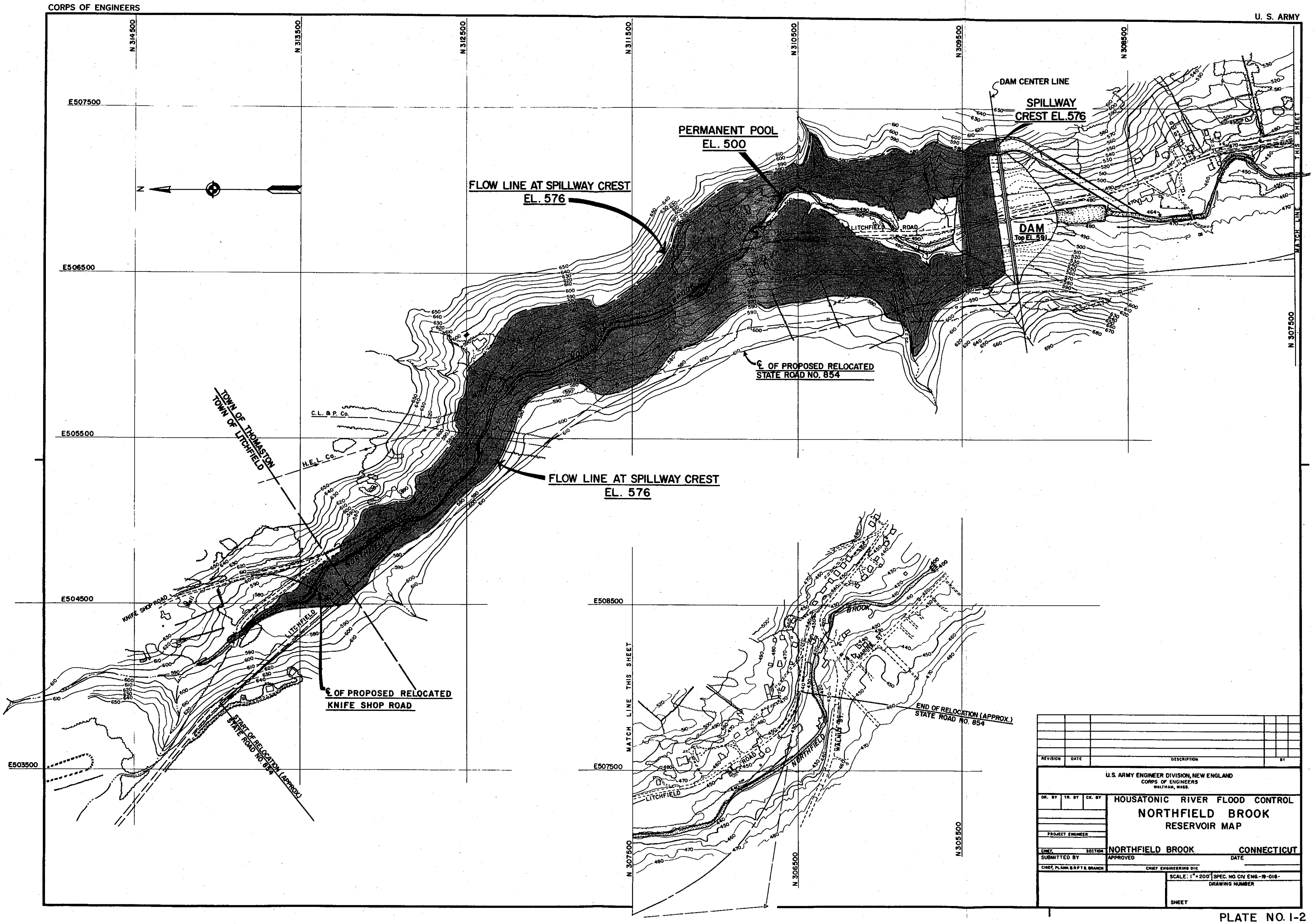
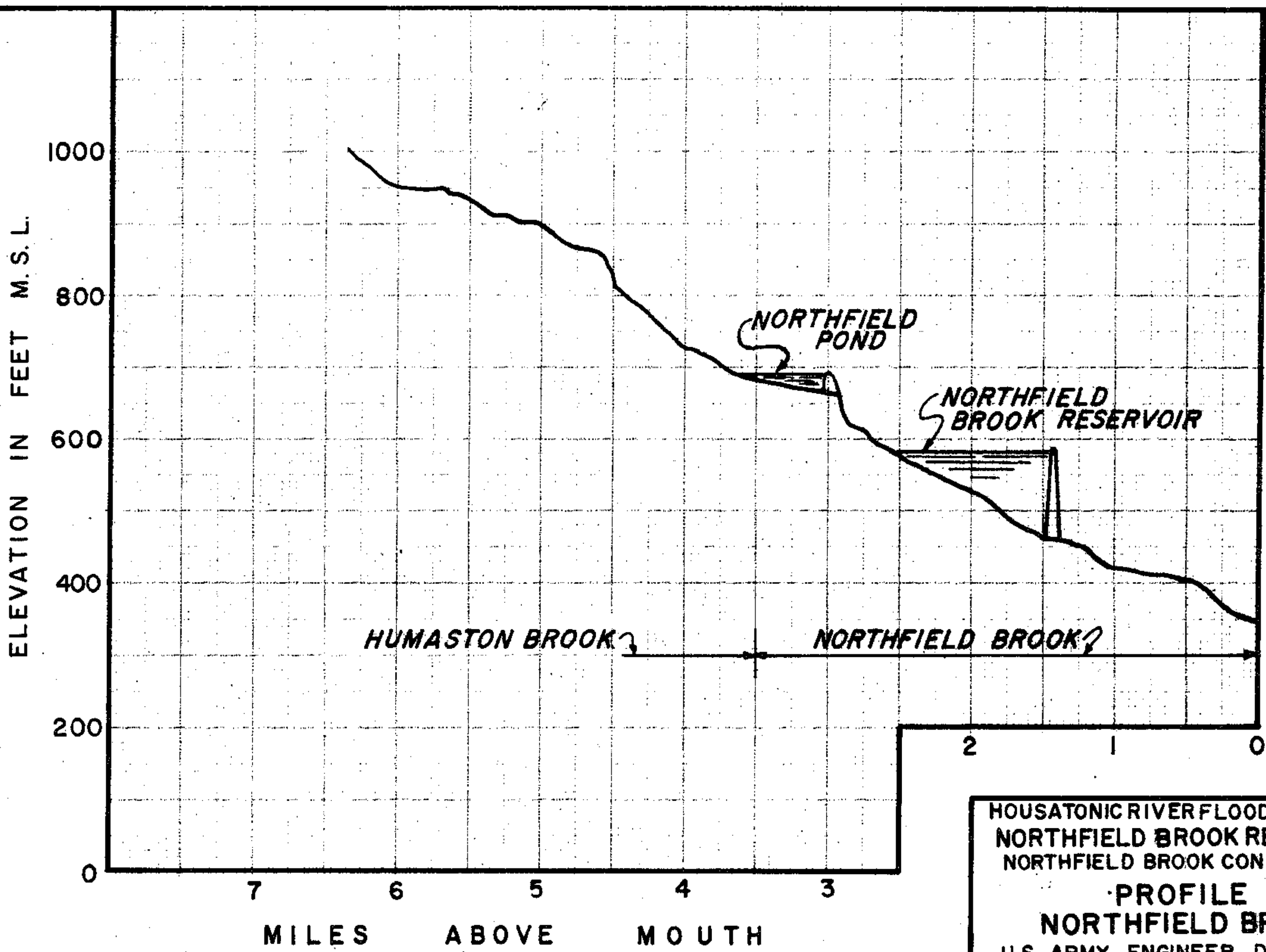

CORPS OF ENGINEERS
U. S. ARMY
DAM CENTER LINE
SPILLWAY CREST EL. 576
PERMANENT POOL EL. 500
FLOW LINE AT SPILLWAY CREST EL. 576
DAM Top El. 591
LITCHFIELD ROAD
℄ OF PROPOSED RELOCATED STATE ROAD NO. 854
TOWN OF THOMASTON
TOWN OF LITCHFIELD
C. L. & P. Co.
H. E. L. Co.
FLOW LINE AT SPILLWAY CREST EL. 576
KNIFE SHOP ROAD
LITCHFIELD
℄ OF PROPOSED RELOCATED KNIFE SHOP ROAD
START OF RELOCATION (APPROX.) STATE ROAD NO. 854
END OF RELOCATION (APPROX.) STATE ROAD NO. 854
MATCH LINE THIS SHEET
BROOK
NORTHFIELD
WALNUT ST.
MARINE ST.
N 314500
N 313500
N 312500
N 311500
N 310500
N 309500
N 308500
N 307500
N 306500
N 305500
E507500
E506500
E505500
E504500
E503500
E508500
REVISION
DATE
DESCRIPTION
BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
DR. BY
TR. BY
CK. BY
HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK
RESERVOIR MAP
PROJECT ENGINEER
CHIEF, SECTION
NORTHFIELD BROOK CONNECTICUT
SUBMITTED BY
APPROVED
DATE
CHIEF, PLANN. & RPTS. BRANCH
CHIEF ENGINEERING DIV.
SCALE: 1" = 200'
SPEC. NO. CIV. ENG.-19-016-
DRAWING NUMBER
SHEET

PLATE NO. I-2

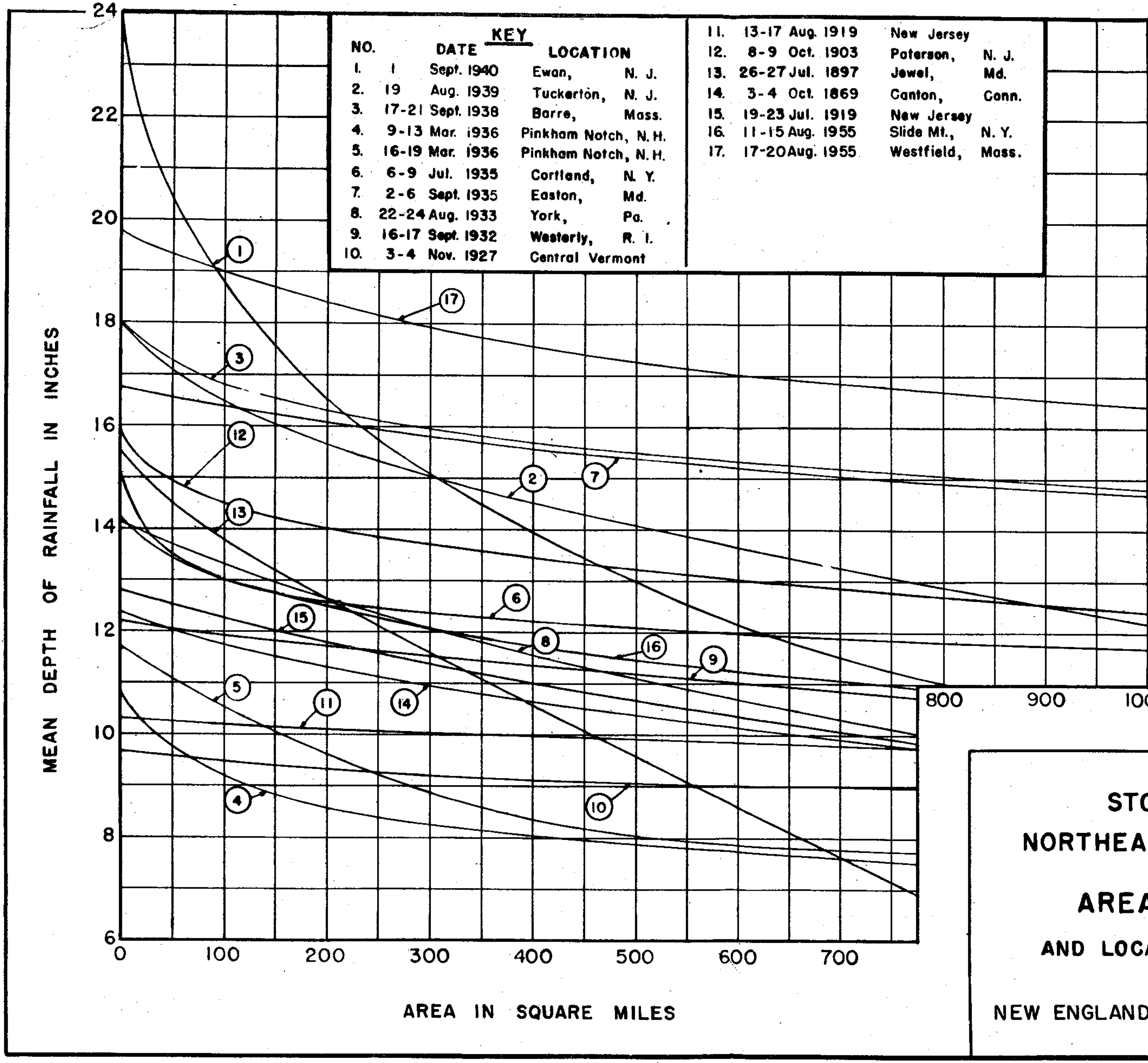


HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK RESERVOIR
NORTHFIELD BROOK CONNECTICUT

PROFILE
NORTHFIELD BROOK

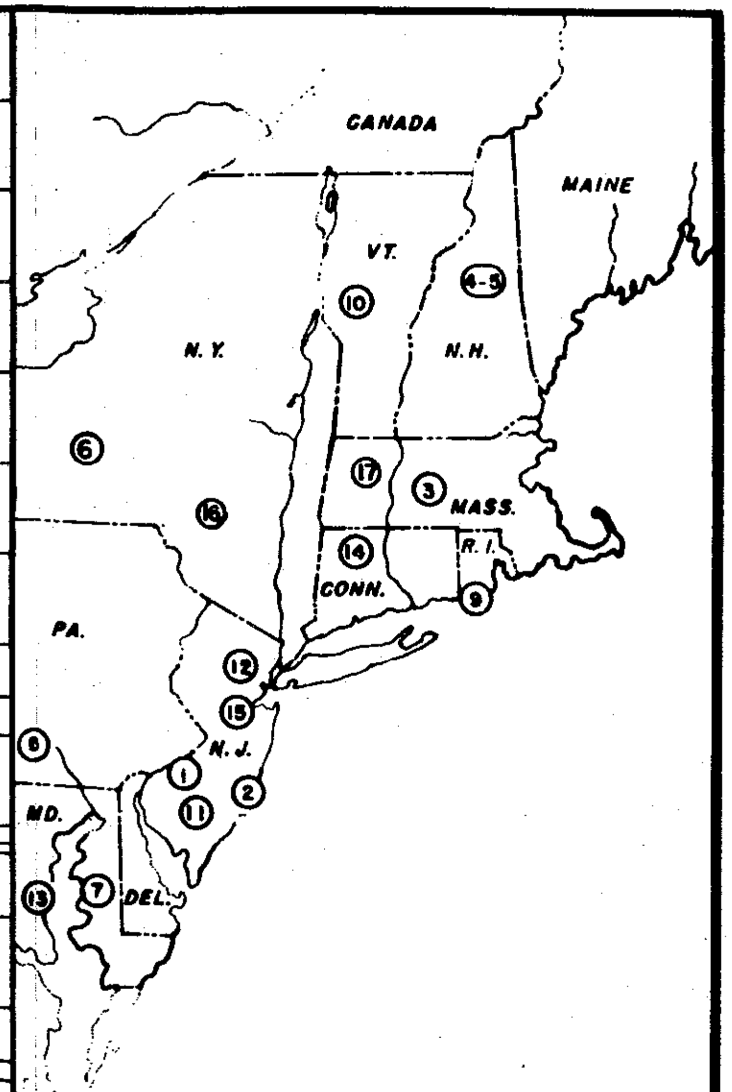
U.S. ARMY ENGINEER DIVISION
NEW ENGLAND
WALTHAM, MASS. APRIL 1962

PLATE NO. 1-3



KEY

NO.	DATE	LOCATION	
1.	1 Sept. 1940	Ewan,	N. J.
2.	19 Aug. 1939	Tuckerton,	N. J.
3.	17-21 Sept. 1938	Barre,	Mass.
4.	9-13 Mar. 1936	Pinkham Notch,	N. H.
5.	16-19 Mar. 1936	Pinkham Notch,	N. H.
6.	6-9 Jul. 1935	Cortland,	N. Y.
7.	2-6 Sept. 1935	Easton,	Md.
8.	22-24 Aug. 1933	York,	Pa.
9.	16-17 Sept. 1932	Westerly,	R. I.
10.	3-4 Nov. 1927	Central Vermont	
11.	13-17 Aug. 1919	New Jersey	
12.	8-9 Oct. 1903	Paterson,	N. J.
13.	26-27 Jul. 1897	Jewel,	Md.
14.	3-4 Oct. 1869	Canton,	Conn.
15.	19-23 Jul. 1919	New Jersey	
16.	11-15 Aug. 1955	Slide Mt.,	N. Y.
17.	17-20 Aug. 1955	Westfield,	Mass.



LOCATION OF STORM CENTERS

STORMS OF RECORD NORTHEASTERN UNITED STATES

AREA-DEPTH CURVES

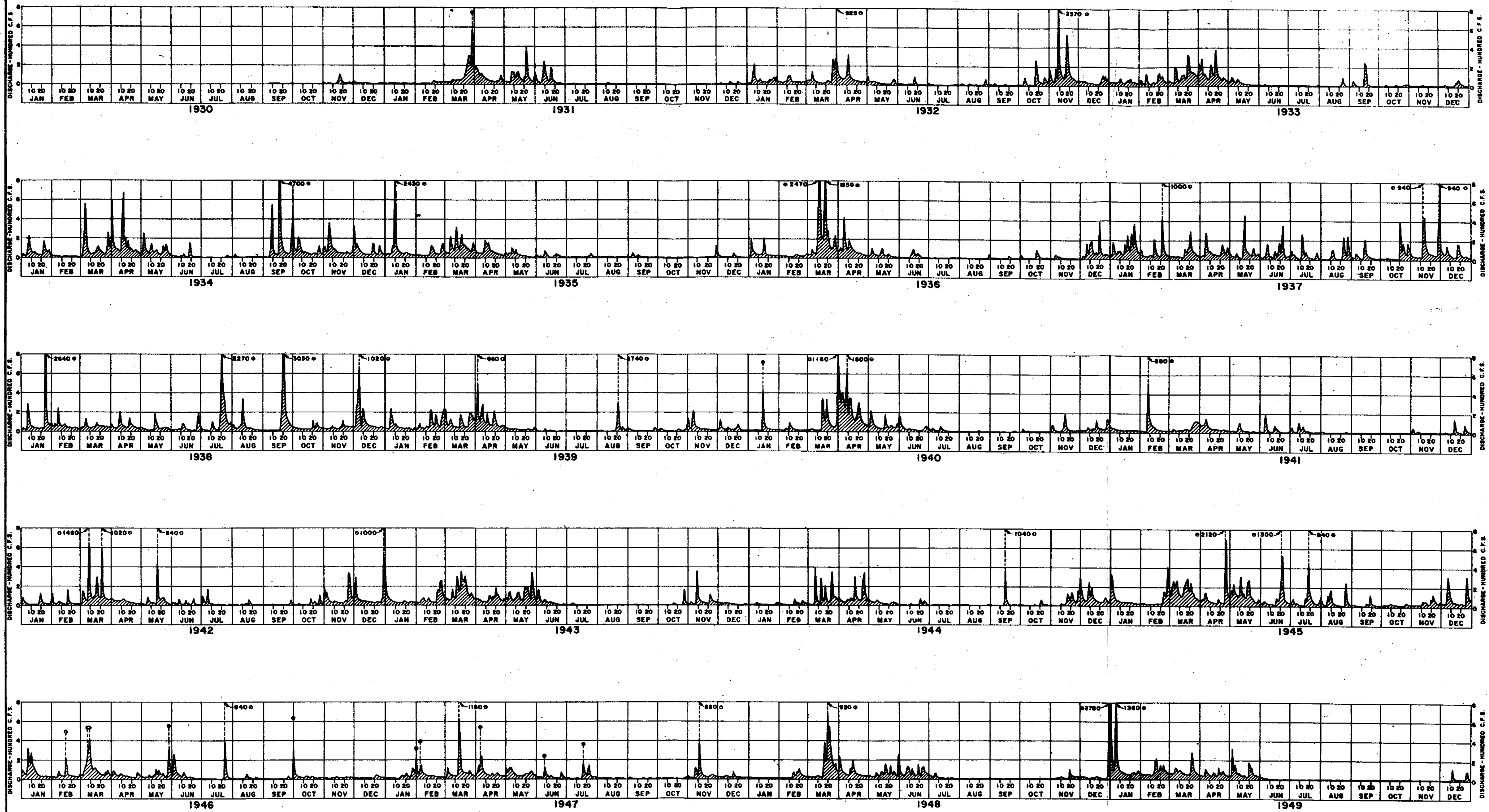
AND LOCATION OF STORM CENTERS

NEW ENGLAND DIVISION BOSTON, MASS

FEBRUARY, 1960

CORPS OF ENGINEERS

U. S. ARMY



NOTES

These hydrographs are the daily average stream flow record of Leadmine Brook near Thomaston, Connecticut from the tributary drainage area of 24.0 Square Miles.

Instantaneous peak discharges where available are shown by ⊙

REVISION	DATE	DESCRIPTION	BY

U S ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY. B.S.J. | TR. BY S.F.C. | CK. BY G.F.S.

SUBMITTED BY

CHIEF HYD. & HYD. SECTION

SUBMITTED BY

PROJECT ENGINEER

APPROVED

CHIEF, PLANN. & RP'TS. BRANCH

APPROVED

CHIEF ENGINEERING DIV.

HOUSATONIC RIVER FLOOD CONTROL

LEADMINE BROOK

HYDROGRAPHS NO. 1

LEADMINE BROOK CONNECTICUT

DATE

SCALE AS SHOWN

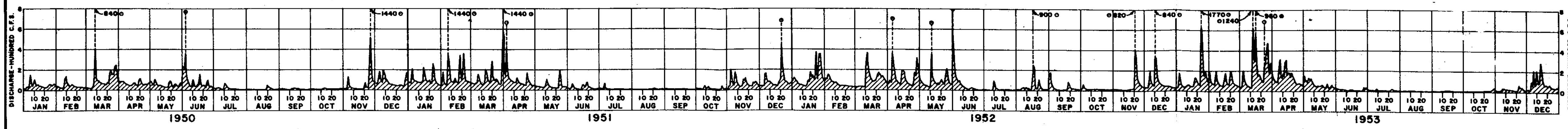
DRAWING NUMBER

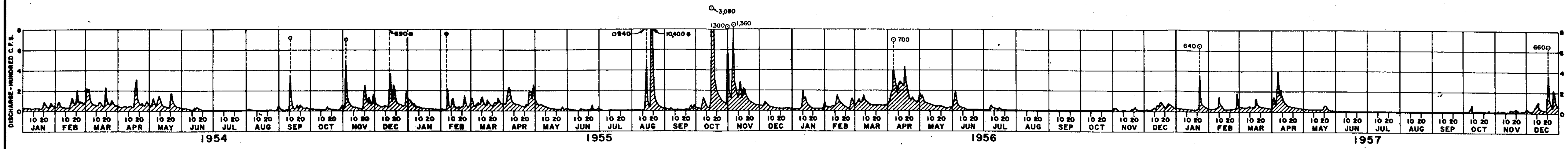
SHEET

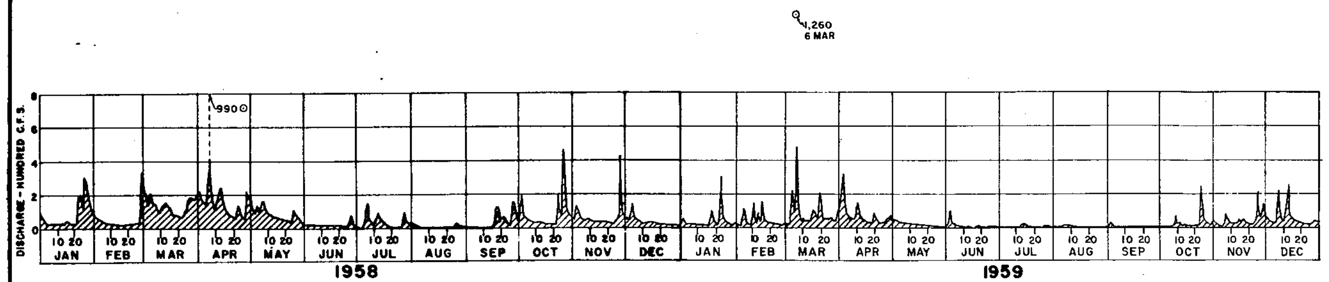
PLATE NO. 1-5

CORPS OF ENGINEERS

U. S. ARMY







REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DR. BY	TR. BY	CK. BY
B.S.J.	B.F.G.	G.F.B.

SUBMITTED BY

CHIEF HYD. & HYD. SECTION

SUBMITTED BY

PROJECT ENGINEER

APPROVED

CHIEF, PLANN. & P'TS. BRANCH

APPROVED

CHIEF ENGINEERING DIV.

HOUSATONIC RIVER FLOOD CONTROL

LEADMINE BROOK

HYDROGRAPHS NO. 2

LEADMINE BROOK CONNECTICUT

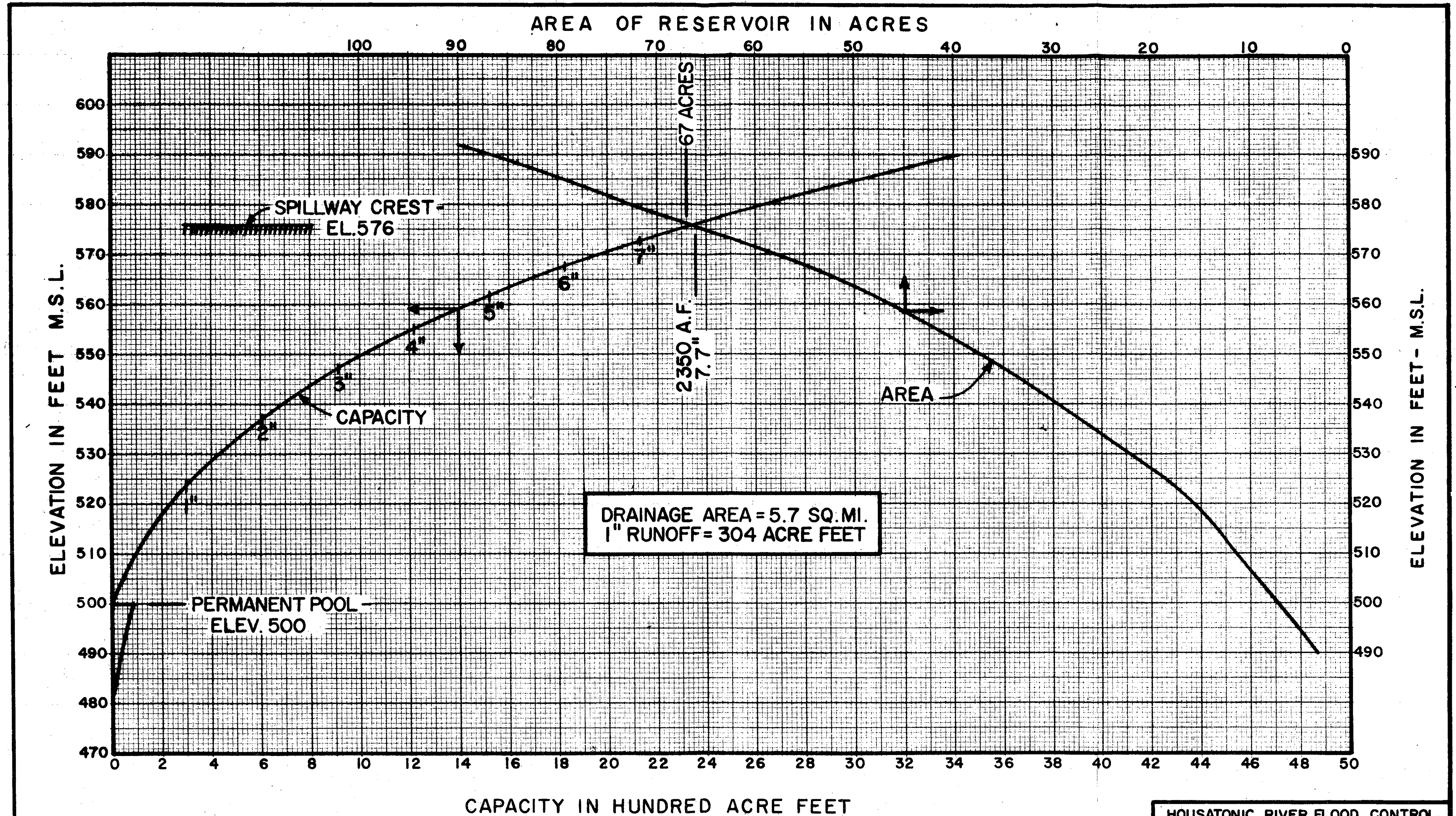
DATE

SCALE AS SHOWN

DRAWING NUMBER

SHEET

PLATE NO. 1-6



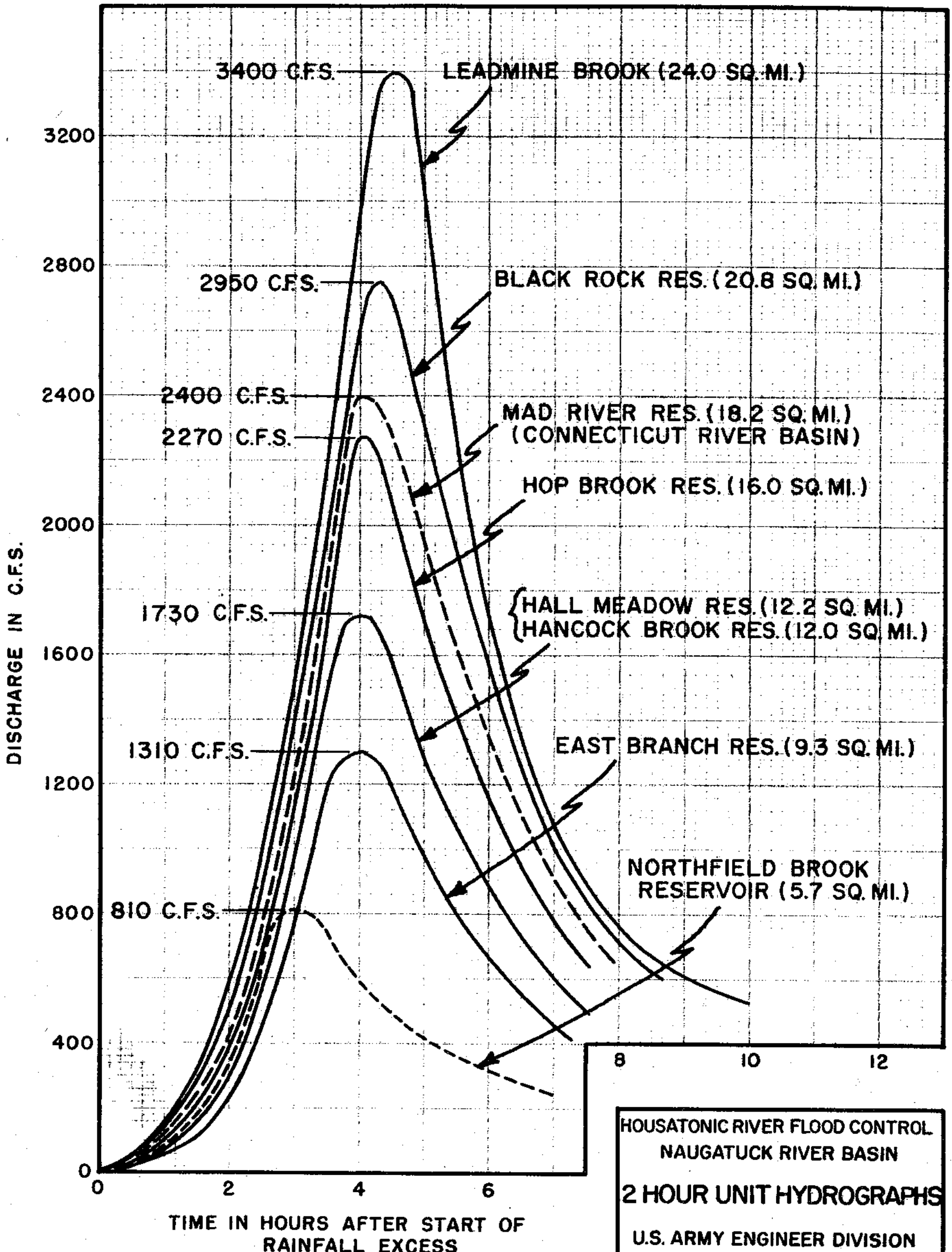
HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK RESERVOIR
NORTHFIELD BROOK CONNECTICUT

AREA-CAPACITY CURVES

U. S. ARMY ENGINEER DIVISION
NEW ENGLAND

WALTHAM, MASS. APRIL 1962

PLATE NO. I-7



HOUSATONIC RIVER FLOOD CONTROL
NAUGATUCK RIVER BASIN

2 HOUR UNIT HYDROGRAPHS

U.S. ARMY ENGINEER DIVISION
NEW ENGLAND
WALTHAM, MASS. APRIL 1962

PLATE NO. I-8

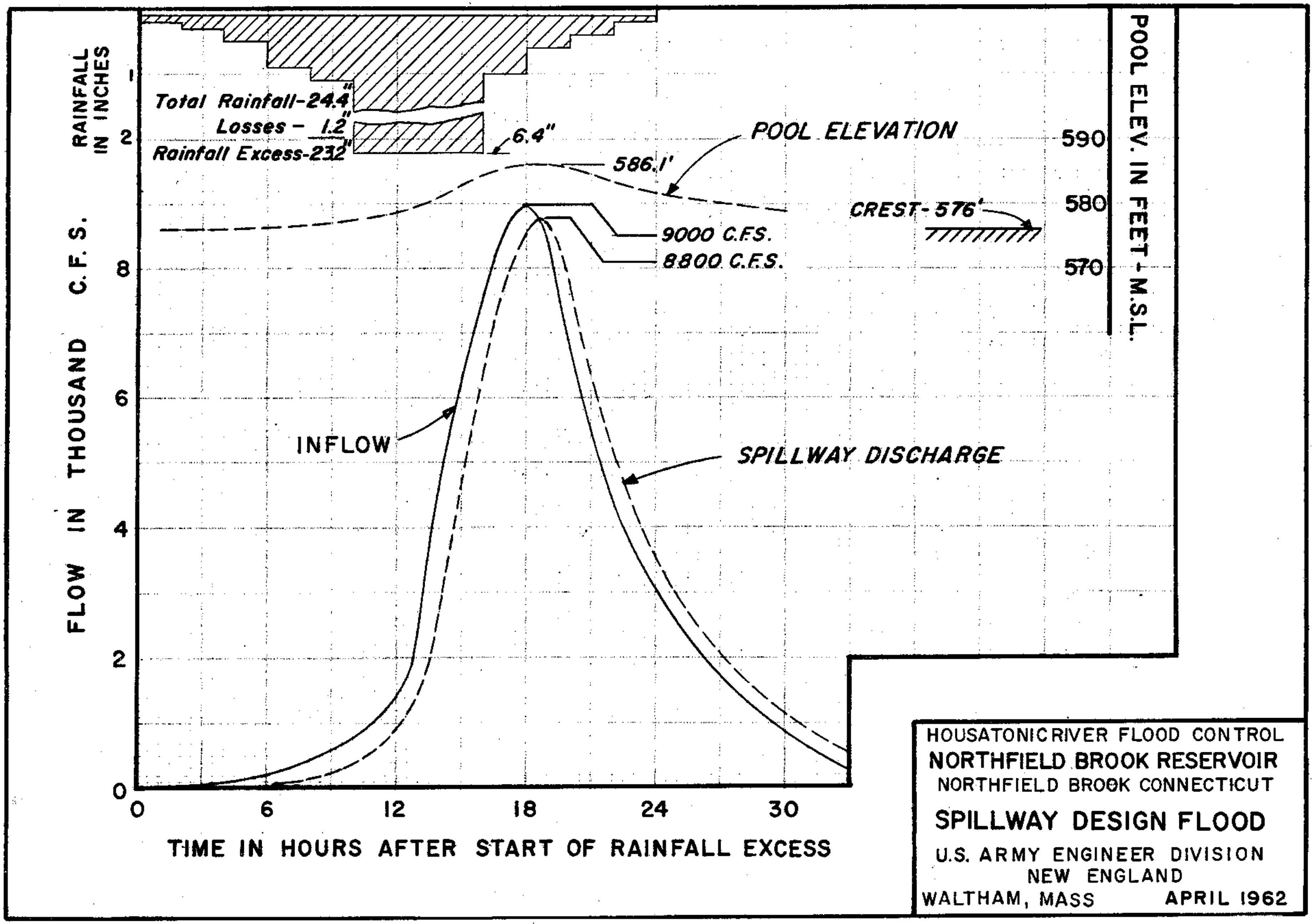
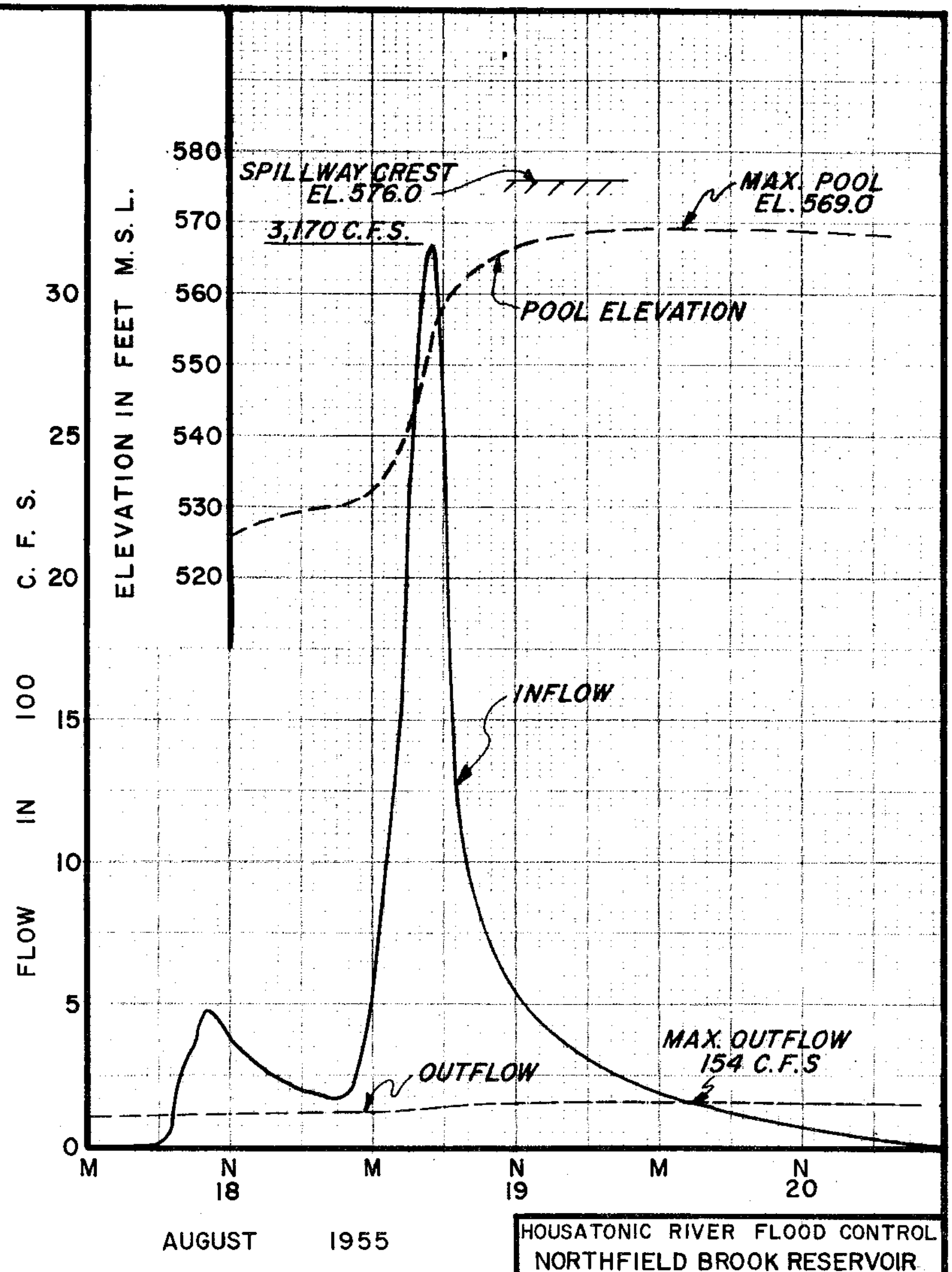

RAINFALL IN INCHES
1
2
Total Rainfall-24.4"
Losses - 1.2"
Rainfall Excess-23.2"
6.4"
POOL ELEVATION
586.1'
9000 C.F.S.
8800 C.F.S.
CREST - 576'
590
580
570
POOL ELEV. IN FEET - M.S.L.
FLOW IN THOUSAND C.F.S.
0
2
4
6
8
INFLOW
SPILLWAY DISCHARGE
0
6
12
18
24
30
TIME IN HOURS AFTER START OF RAINFALL EXCESS
HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK RESERVOIR
NORTHFIELD BROOK CONNECTICUT
SPILLWAY DESIGN FLOOD
U.S. ARMY ENGINEER DIVISION
NEW ENGLAND
WALTHAM, MASS
APRIL 1962

PLATE NO. I-9



HOUSATONIC RIVER FLOOD CONTROL

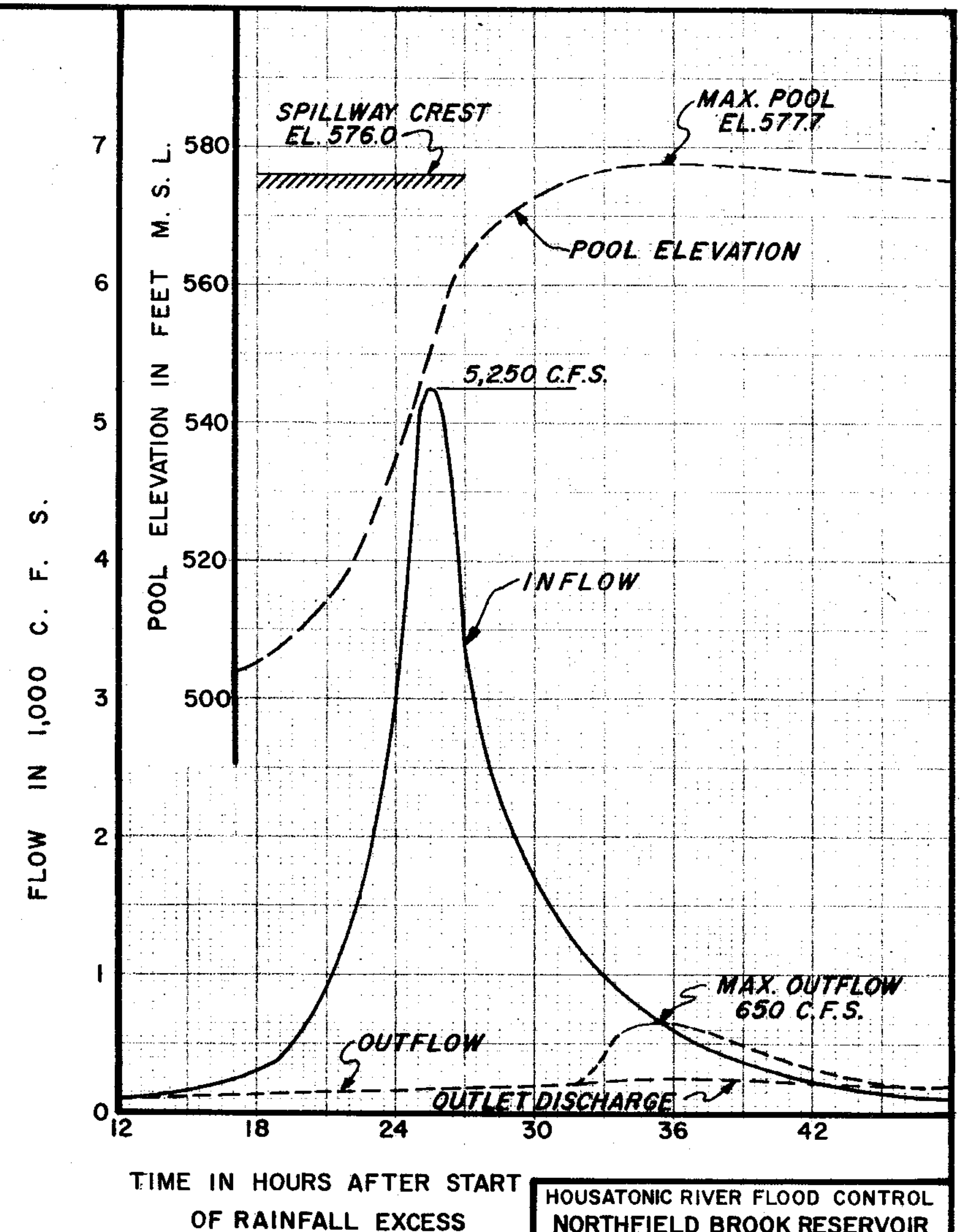
NORTHFIELD BROOK RESERVOIR

NORTHFIELD BROOK, CONNECTICUT

FLOOD OF AUGUST 1955

U.S. ARMY ENGINEER DIVISION
NEW ENGLAND
WALTHAM, MASS. APRIL 1962

PLATE NO. 1-10

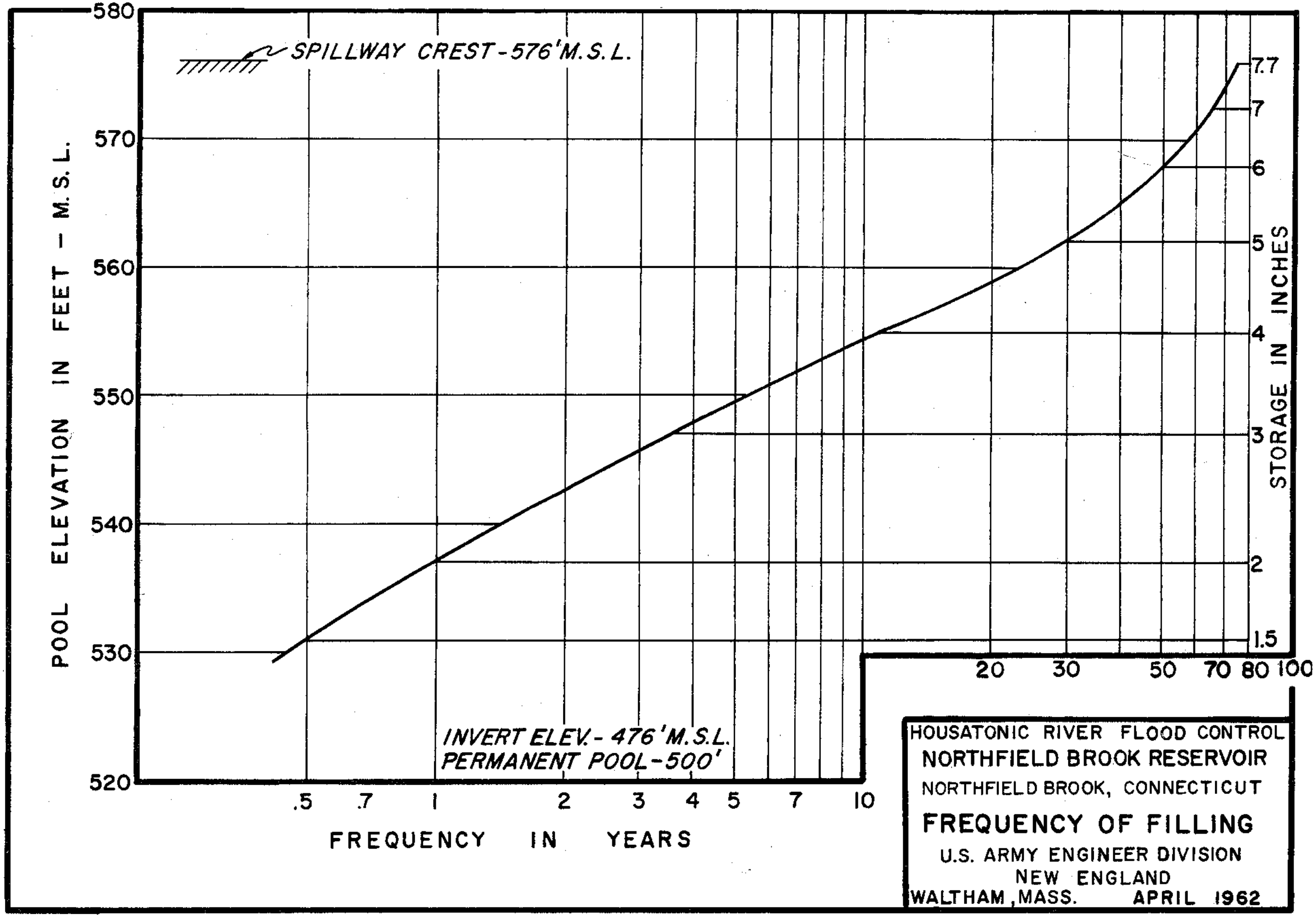


HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK RESERVOIR
NORTHFIELD BROOK CONNECTICUT

STANDARD PROJECT FLOOD

U.S. ARMY ENGINEER DIVISION
NEW ENGLAND
WALTHAM, MASS. APRIL 1962

PLATE NO. I-11



HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK RESERVOIR
NORTHFIELD BROOK, CONNECTICUT

FREQUENCY OF FILLING

U.S. ARMY ENGINEER DIVISION
NEW ENGLAND
WALTHAM, MASS. APRIL 1962

PLATE NO. 1-12

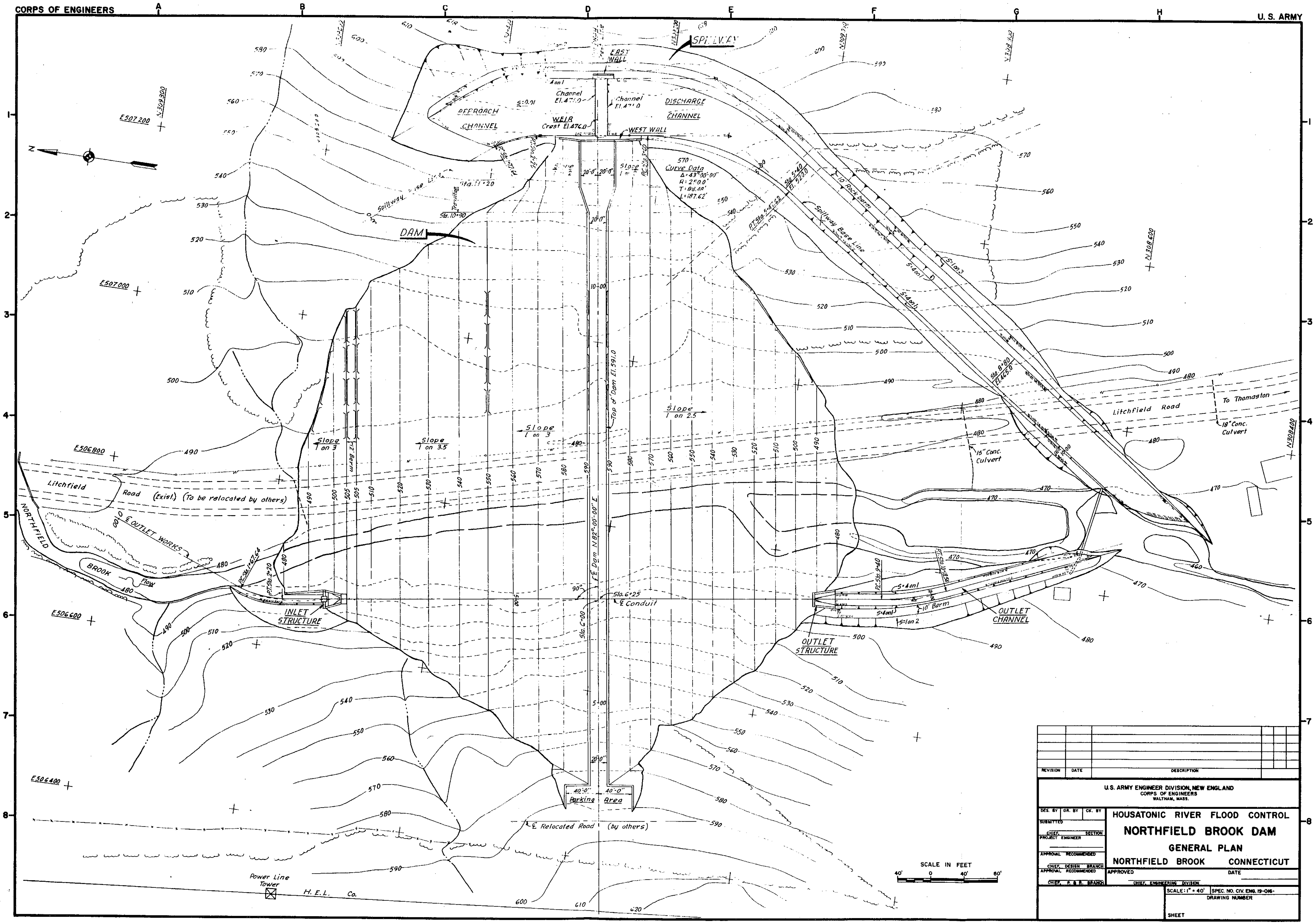

CORPS OF ENGINEERS
U. S. ARMY
SPILLWAY
EAST WALL
WEST WALL
APPROACH CHANNEL
DISCHARGE CHANNEL
WEIR
Crest El.476.0
Curve Data
DAM
Top of Dam El.591.0
Slope 1 on 3
Slope 1 on 3.5
Slope 1 on 2.5
Spillway Base Line
10' Rock berm
Litchfield Road
To Thomaston
18" Conc. Culvert
15" Conc. Culvert
Litchfield Road (Exist.) (To be relocated by others)
NORTHFIELD BROOK
Flow
℄ OUTLET WORKS
INLET STRUCTURE
℄ Conduit
OUTLET STRUCTURE
OUTLET CHANNEL
10' Berm
Parking Area
℄ Relocated Road (by others)
Power Line Tower
H. E. L. Co.
SCALE IN FEET
REVISION
DATE
DESCRIPTION
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
DES. BY
DR. BY
CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P. & R. BRANCH
HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK DAM
GENERAL PLAN
NORTHFIELD BROOK CONNECTICUT
APPROVED
DATE
CHIEF, ENGINEERING DIVISION
SCALE: 1" = 40'
SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE NO. 1-13

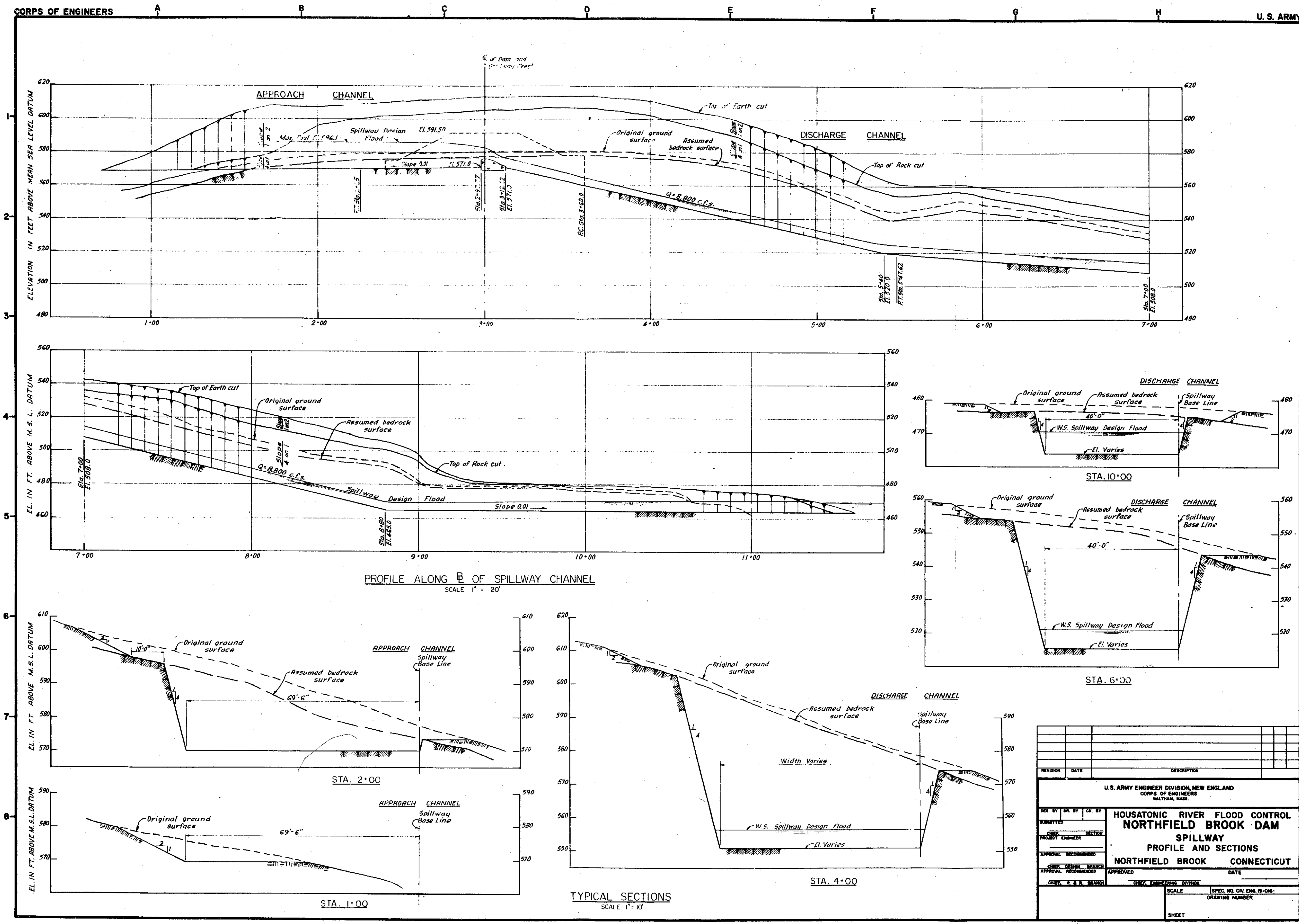
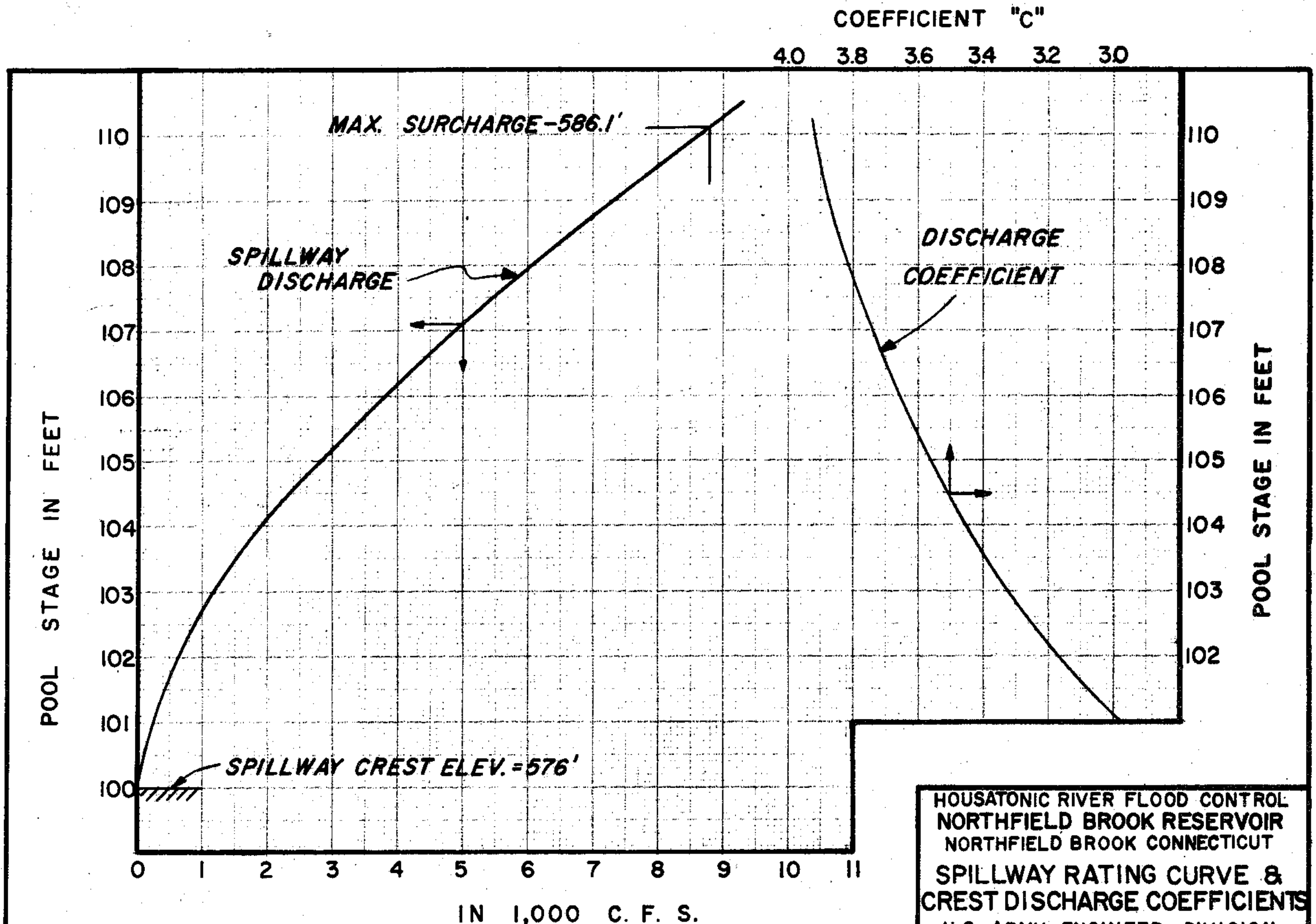

CORPS OF ENGINEERS
U. S. ARMY
APPROACH CHANNEL
DISCHARGE CHANNEL
Top of Earth cut
Original ground surface
Assumed bedrock surface
Top of Rock cut
Spillway Design Flood
Max. Pool El. 596.1
El. 591.50
Slope 0.01
El. 571.0
Q = 8,800 c.f.s.
ELEVATION IN FEET ABOVE MEAN SEA LEVEL DATUM
EL. IN FT. ABOVE M.S.L. DATUM
PROFILE ALONG ℄ OF SPILLWAY CHANNEL
SCALE 1" = 20'
W.S. Spillway Design Flood
El. Varies
Spillway Base Line
40'-0"
69'-6"
10'-0"
Width Varies
STA. 10+00
STA. 6+00
STA. 2+00
STA. 4+00
STA. 1+00
TYPICAL SECTIONS
SCALE 1" = 10'
REVISION DATE DESCRIPTION
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK DAM
SPILLWAY
PROFILE AND SECTIONS
NORTHFIELD BROOK CONNECTICUT
SPEC. NO. CIV. ENG. 19-016-

PLATE NO. 1-14

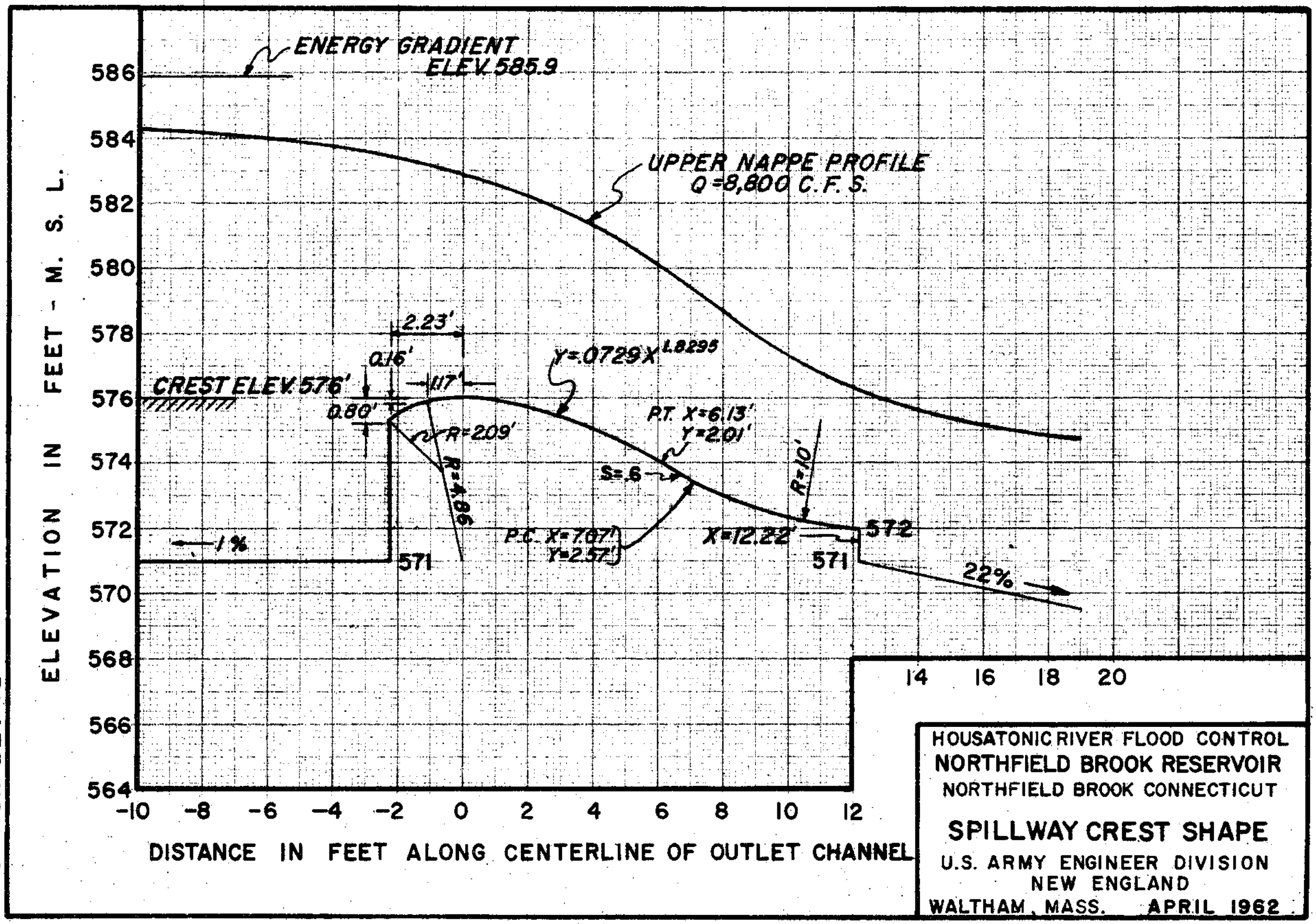


HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK RESERVOIR
NORTHFIELD BROOK CONNECTICUT

SPILLWAY RATING CURVE & CREST DISCHARGE COEFFICIENTS

U.S. ARMY ENGINEER DIVISION
NEW ENGLAND
WALTHAM, MASS. APRIL 1962

PLATE NO. I-15



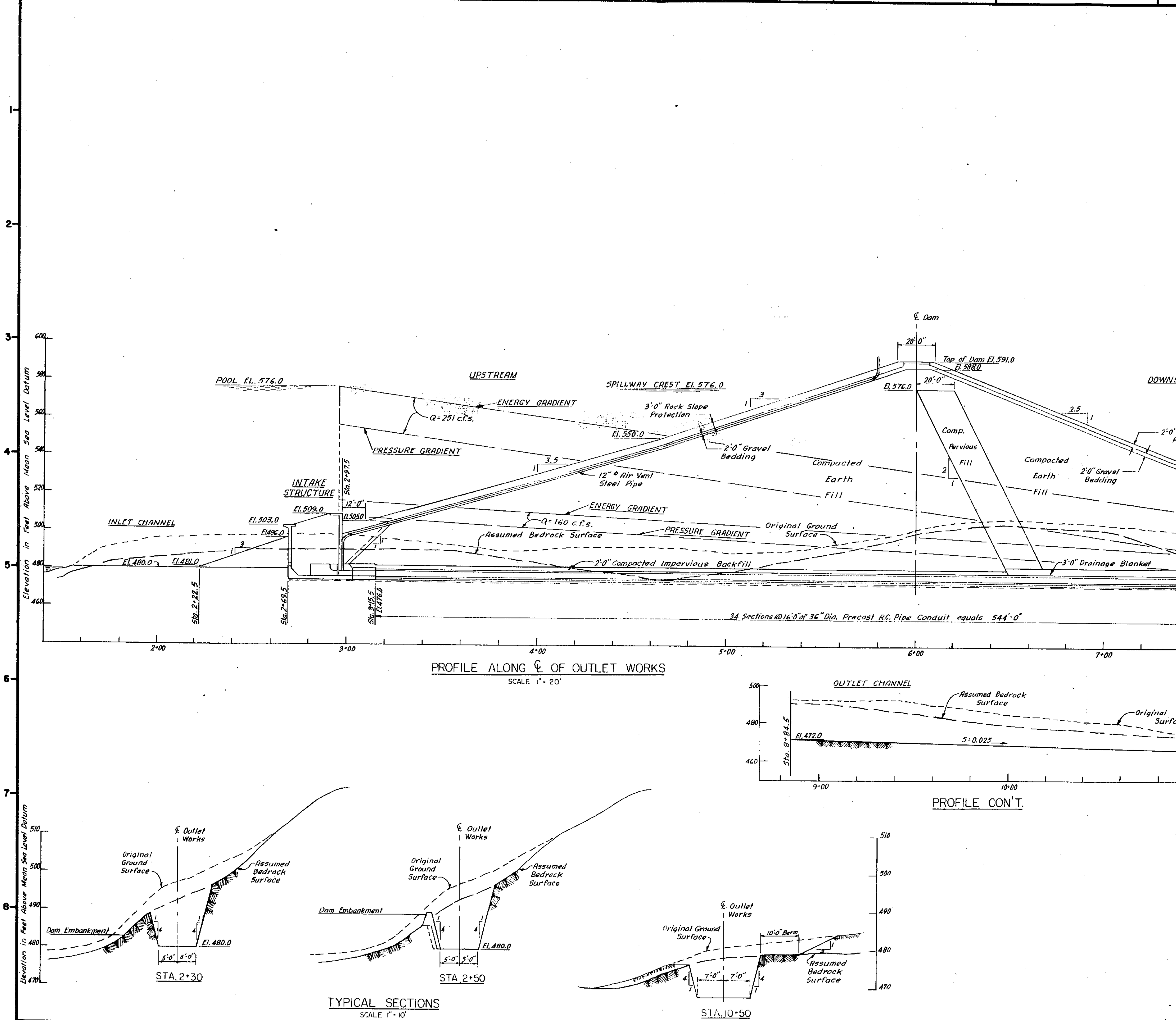
HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK RESERVOIR
NORTHFIELD BROOK CONNECTICUT

SPILLWAY CREST SHAPE

U.S. ARMY ENGINEER DIVISION
NEW ENGLAND
WALTHAM, MASS. APRIL 1962

PLATE NO. I-16

CORPS OF ENGINEERS U. S. ARMY



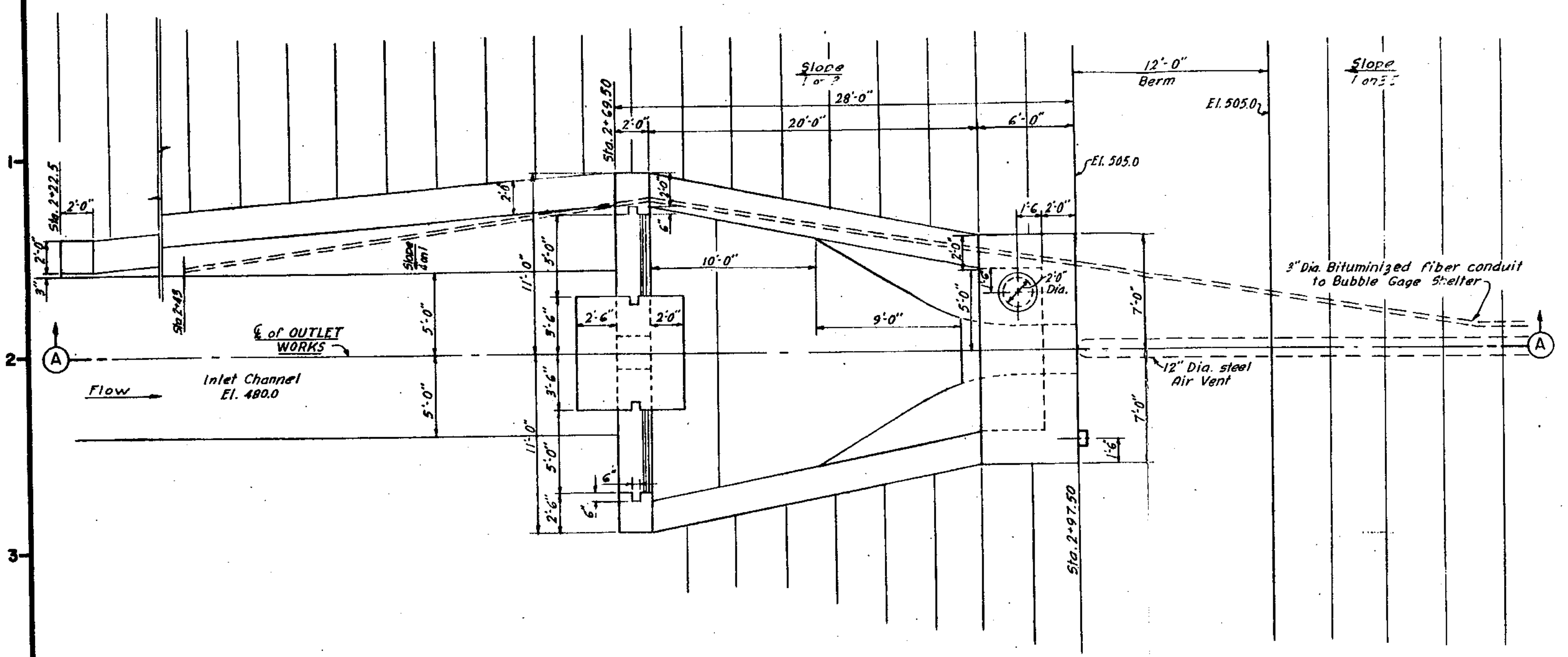
REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

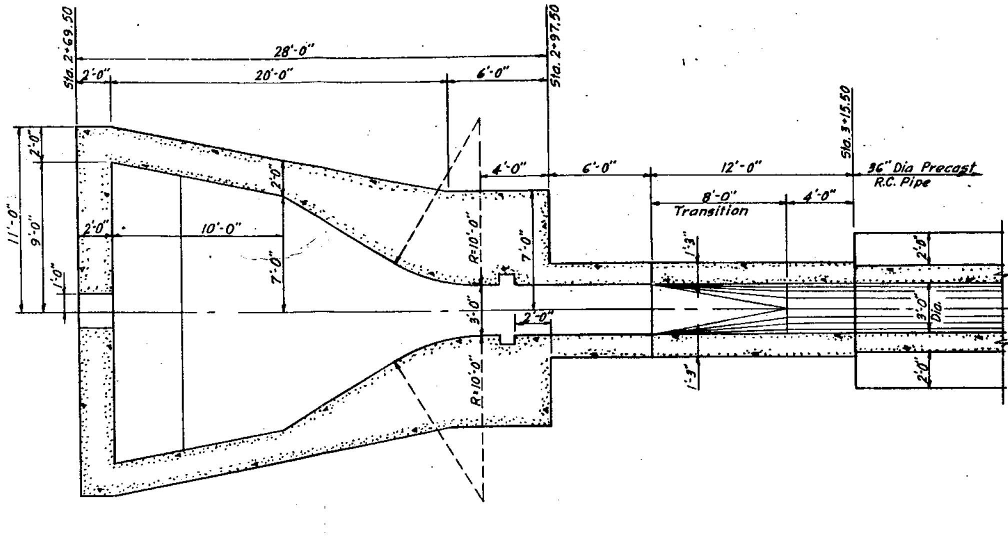
HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK DAM
OUTLET WORKS
PROFILE AND SECTIONS
NORTHFIELD BROOK CONNECTICUT

DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, E. & R. BRANCH
APPROVED
DATE
CHIEF, ENGINEERING DIVISION
SCALE
SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

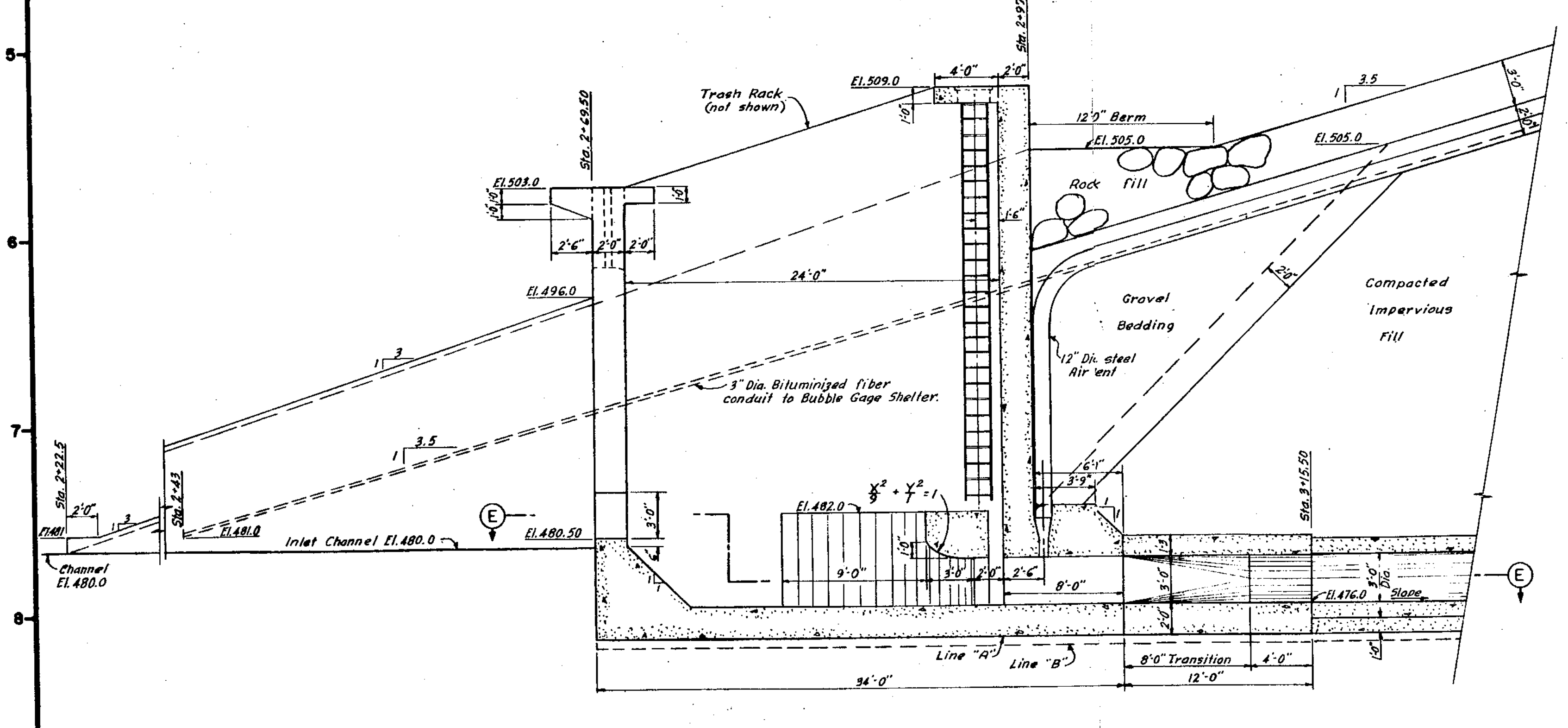
PLATE NO. 1-17



PLAN



SECTION E-E



SECTION A-A

SCALE IN FEET

REVISION	DATE	DESCRIPTION

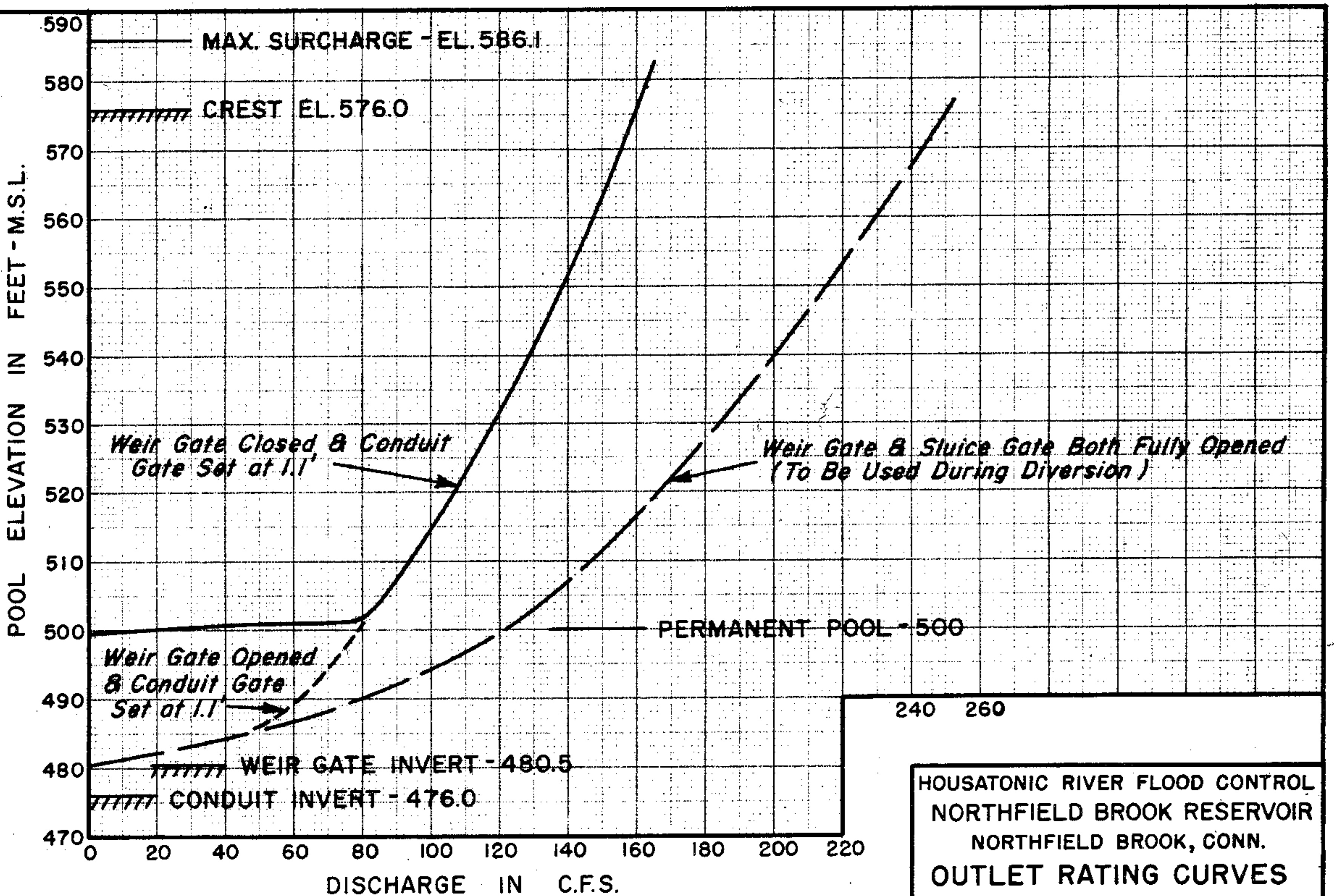
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, F. & E. BRANCH

HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK DAM
OUTLET WORKS
INTAKE STRUCTURE
NORTHFIELD BROOK CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE: 1/4" = 1'-0" | SPEC. NO. CIV. ENG. 19-018-
DRAWING NUMBER
SHEET



HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK RESERVOIR
NORTHFIELD BROOK, CONN.

OUTLET RATING CURVES

U.S. ARMY ENGINEER DIVISION
NEW ENGLAND
WALTHAM, MASS. APRIL 1962

PLATE NO. I-19